Turning The Tide

Essays on Dutch ways with water

Henk L.F. Saeijs

Turning The Tide

Essays on Dutch ways with water

Cover picture
Citizens of the village Arcen en Velden, near Venlo, constructing an emergency dyke.
Photographer: Raymond Rutting, courtesy ANP. Date: 30-01-1995

About the author

Professor Henk L.F. Saeijs (1935) studied biology (Utrecht) and aquatic ecology (Amsterdam) and gained his doctorate with the thesis 'Changing Estuaries' (Leiden). In this thesis he showed the relationship between technology, ecology and administration during large hydrological projects and in doing so, he laid the foundation for modern water management which is based on a holistic and ecological approach. For twelve years he managed Environmental Research at the Delta Project and for a further six years was Chief of Water Management at the Central Management Office of the Ministry of Public Waterworks and Water Management.

There he was the spiritual father and driving force behind modernization and "ecologization" of water management (integral water management, water system approach, active biological management, guided ecosystem development, etc.). After having been Acting Manager of the Directorate Noordzee he was appointed Director Zeeland (a Dutch province). Among other activities he is a member of the 'International Commission on Large Dams' (ICOLD), chairman of the Dutch delegation (NETHCOLD) and chairman of the international Committee on the role of dams in river basins. He advised a number of large water hydrological projects outside Nederland such as the storm surge barrier at Saint Petersburg. For 10 years he was a professor of water management at the Erasmus University of Rotterdam. He has lectured at countless gatherings and has written many articles for (inter)national journals and symposia. These many achievements brought him royal recognition for public services by being appointed an Officer in the Order of Oranje Nassau (one of the highest Dutch honors to be awarded).

Turning The Tide

Essays on Dutch ways with water

H.L.F. Saeijs

VSSD

First edition 2006 Dutch, entitled "Weg van Water"
First edition English language version 2008
Cofinanced by Rijkswaterstaat

Ministry of Transport, Public Works and Watermanagement

Translated by Paul Karis of MCT, Woubrugge, The Netherlands.
Proof reading by David Bloch of Perfect Presentation.

Published by:

VSSD
Leeghwaterstraat 42, 2628 CA Delft, The Netherlands
tel. +31 15 278 2124, telefax +31 15 278 7585, e-mail: hlf@vssd.nl
internet: http://www.vssd.nl/hlf
URL on this book: http://www.vssd.nl/hlf/f037.htm

Teachers wishing to adopt this book as training material may request the illustrations from hlf@vssd.nl

Printed version: EAN 978-90-6562-168-9
Electronic version: EAN 978-90-6562-181-8

NUR 943
Key words: water management, ecology

"We are facing the challenge to find a new relation to nature, where respect for ecological balance, cautious and caring measures are prime considerations"

H.M. Queen Beatrix, 1999

Preface

Dutch history is characterized by a constant struggle against water. For centuries the inhabitants of the Low Countries have been fighting the rising level of the sea and the rivers.
Displaying their technical genius they developed defence strategies, ranging from primitive terps to technical marvels such as the Delta Works. By the end of the 19th century a new problem presented itself: pollution. The Dutch society was not only threatened by the amount of water but also by its quality.
One could say that the Dutch water problems have swollen to torrential proportions. Protection against flood disasters is still the main objective and has become even more complicated by factors that are hard to forecast, such as the rise of the sea level with simultaneous sinking of the land.
Quite paradoxically Nederland is increasingly confronted with a shortage of water, high quality fresh drinking water to be precise.
When distributing this water, different and often conflicting interests need to be weighed against each other: the need for housing, the requirement of water for agriculture, nature and ecology. This kind of interactive, yet differing interests have made water management a complex affair.

My motto "problems don't exist, only challenges do" has guided the path in my working years and provided me with the required enthusiasm when dealing with water management.
I have had the good fortune to have first hand experience with all the pro's and cons within the department of Water Management, in what may very well be termed one of the most exciting periods of Dutch water management.
Even after my retirement I am still bombarded with questions on this very subject. To me this is proof that even today many people are concerned with its different aspects.
This led to the idea that it might be useful to put the experiences and knowledge I have gathered over the past decades on record.
I hope this publication will deepen the reader's understanding of the turbulent developments over the last 30 years and contribute to sharpening the insight of present and future water managers.

This little bundle of 17 essays has been written and collected with a broad audience in mind. It includes businessmen, politicians, water managers, students and last but not least the large group of interested members of the general public, who simply wish to know more about the aspects in the background of this area that is so vital to their country.

Mainly because of this broad spectrum I refrained from placing references to source literature in the text and sufficed with a list following the essays.
The essays can be read on their own in any sequence. When choosing for a bundle of essays one can hardly avoid that some subjects will be mentioned more than once, sometimes from different viewpoints when this fits the flow and argumentation of a specific essay.

I hope that the kaleidoscope of all the essays jointly will shed some relevant light on the problems and complexity of the world of water. The common feature is the process of rejuvenation in the field of water management, the "wet revolution", "ecologisation" and the global impact. I have not sidestepped anecdotes and personal experiences. Discussions go with the flow, be it the flow of salt or the flow of fresh water.
The title "Turning The Tide" encompasses more than that. It symbolizes our fear of water, yet at the same time it stands for my passion for water, a passion I share with many others.

The foreign readership will in many cases not be familiar with the topography of the Netherlands. Those essays that discuss Dutch matters inevitably contain Dutch names. I have chosen not to translate those names, even if there is an English name for e.g. the Rhine, the Scheldt, the Meuse, The Hague, Antwerp, or even The Netherlands. So all topographical names have been kept in Dutch, and to be of some help to readers who wonder where all those places are to be found, a map has been included on page 142.

Acknowledgements
Books like this are never the work of only one person, so I would like to thank those who helped me. In the first place my gratitude is to Jacques Schievink, who impressed upon me the importance of transferring knowledge and experience in this way, helping me with his constant drive and enthusiasm to bring this task to a fruitful end.
I further owe thanks to all those who have cooperated with me in the past forty years when writing hundreds of lectures and articles. Some of these articles have inspired a few essays of this book.
That is the main reason for mentioning Leo Adiaanse and Inez Flameling by name, very closely followed by Leo Santbergen, Cees-Jan van Westen en Madelinde Winnubst, Mark van Berkel, and Toine Smits, Willem Overmars and Daphne Willems for their indirect contributions. Finally a warm word of thanks to Annie van der Meer and my daughters, Astrid and Geesje Saeijs, who were always there with good advice and a helping hand.

Henk L.F. Saeijs
Middelburg, April 2008

Contents

1

Water, blessed and cursed

1.1 Water, our unique life elixir

Billions of years ago Earth was still a fiery ball of liquid magma. This gradually cooled down. Here and there a crust of earth was formed. This crust harboured many volcanoes that produced gases which were heavily laden with vaporized water that spouted in the atmosphere.
Once Earth and its atmosphere had sufficiently cooled down, the vapor condensed and the world saw its first rain. Valleys were submerged and transformed into lakes, seas and oceans.
Life would not exist if it were not for water. There wouldn't be a single plant, no animals and no human beings.
Can you imagine a world without water, oceans, seas, rivers, clouds, tropical rain forests or without fields and pastures? Even our very bodies consist for 80% of water. So water is truly our one and only "life elixir".
On our planet there is water in abundance. But almost all this water is salty from the minerals dissolved in it. Not only the seas and oceans contain salt water, but it can also be found in estuaries, lakes and in the ground. Only a fraction of the world's total supply of water is fresh. This fresh water can be found in the air, in rivers and lakes, on the polar icecaps, in glaciers high in the mountains and of course the groundwater.

1.2 Water has remarkable properties

Given a certain temperature and pressure, two hydrogen atoms (H) and one oxygen atom (O) will together yield to the molecule of water, symbolized by H_2O. Water is the only material in nature which (dependant of the temperature) can simultaneously manifest itself – in different areas – in one of three forms. As a gas (water vapor), as a liquid (water) and as a solid material (ice).
With the transition from one physical state to another, energy is either generated or required. For example 40% of all solar energy reaching the Earth is used to maintain the cycle of water.
In principle fresh water might be generated and used in a sustainable and responsible manner. It is continually replenished by nature in the "hydrological cycle". Water on the surfaces of seas and oceans (and land) evaporates. Once airborne, water vapor can condense into clouds that are blown by the wind to other areas. From cooling clouds rain or other forms of precipitation falls somewhere on Earth and gathers in streams that flow into rivers to end up in the sea again.
Water also penetrates the soil and eventually seeps through to the sea, but this process

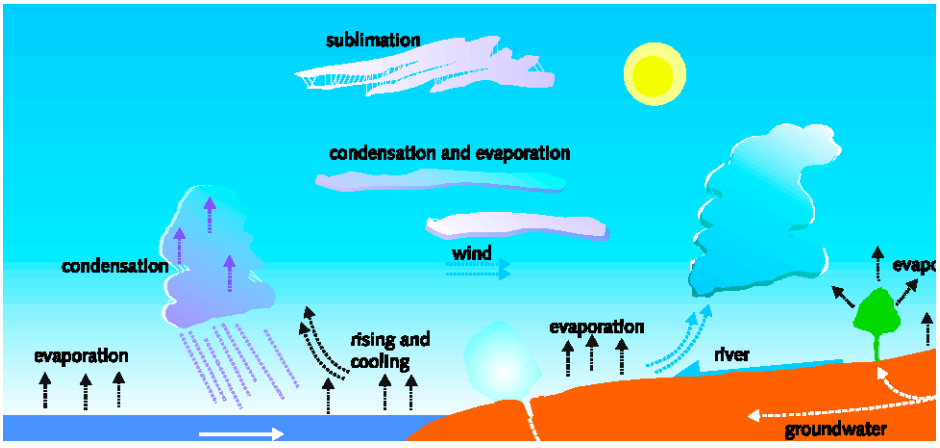
takes much longer. This constitutes the "cycle of water" also known as the hydrological cycle (Picture 1.3).
The hydrological cycle brings about a few typical problems: the total quantity of fresh water on Earth is a scarce commodity and not evenly distributed over its surface. This means that some parts in the world have too much fresh water whilst other parts may be stricken by drought. Another aspect of fresh water is its irreplaceability. Oil, for example, might in principle be replaced by coal, natural gas, sun, wind, tidal energy, or fission, but the commodity water cannot be replaced. It either is or isn't available. There is either plenty or it is in short supply. But even if there is plenty, it needs to be clean as well to be of any use.
Man and his ecosystems depend on clean water. When people pollute water the direct effect is a disturbance of their own ecosystems, which in the end leads to their own downfall.

1.3 Looking after our water supply

One might expect mankind to be extremely careful with its water supply. Nothing could be further from the truth. More and more problems are manifesting themselves. Sometimes the supply of water is too much in too short a time. Then we have a flood. Sometimes the water supply is adequate but it is polluted or poisoned, which makes it unfit for use. At other times water is in short supply, such as during a period of drought. All these problems are mainly caused by mankind. For some time now water managers are no longer in control of the water problems which have become quite complex. Reality presents a far grimmer picture. From an ecological viewpoint most water systems are not functioning as one might expect. Despite all efforts and improvements it needs to be said that all water management problems of the past century are still with us, and new ones are rearing their heads all the time.
This makes active water management strategy vitally important. We need to be clear about the current state of existing infrastructure and water systems management, and about precisely where improvements can be made. What will the water situation be like in 50 years' time?.
I should like to characterize the twentieth century as the century of increasing contrasts. Contrasts between rich and poor, between those yielding power and those under its yoke, between war and peace, flood and drought.
The twentieth century has witnessed two disastrous world wars and hundreds of local wars, genocides, earthquakes and floods adding up to millions and millions of casualties. I fear that this is only the beginning. The world's population is expanding uncontrollably and it acts with absolute power over nature.
Ecological laws are sneezed at. Oceans and continental seas are being depleted of fish. Natural resources such as oil and natural gas are being exhausted, leaving a trail of destruction behind. And thus, in full view yet unnoticed by most, water has become part of an unprecedented ecological global catastrophe. Pollution, deforestation, mudslides, overflowing rivers, climate changes, they all seem isolated incidents, yet they are all caused by the same underlying set of problems.
In short, the problems water management is confronted with can be summed up very concisely: too much, too little, too polluted, disrupted or destroyed.

Picture 1.1 Clouds floating over the Earth and exhibiting the most spectacular patterns, transport gigantic volumes of water. Water is the cornerstone of economic develop-ment and even determines its limits. Water is not only vital for man and his economy, it is the very fluid of life itself. Water is an es-sential part of all life and is the key factor of the ecosystems that sur-round and support all life.

Picture 1.2 A river meandering in in the area of the Amazone. Rain accumulates to rivers. The opaque brown color of the water reveals that the riverbed upstream is being heavily eroded.



Picture 1.3 The cycle of water, or the hydrological cycle (Geografic Cartografic Institute Elsevier, 1978).

2

From "ego-pragmatism" to eco-pragmatism

Water. What conception did the people of the past have? How is it regarded in this day and age? What have we, the inhabitants of the deltas of the Rijn, Maas and Schelde learned in the past 20 centuries about coping with this natural phenomenon? Was draining our moorland and constructing dykes with hindsight such a good idea after all? Aren't we driving ourselves into a tight little corner? And what now?

2.1 The idea of our forebears about water

There was no water management in prehistoric times. Prehistoric hunters, collectors as well as the first farmers were totally dependant on the rain that nature bestowed upon them. Their paradigm [1] was *"Let God's water flow freely over God's acres"*. Water can be a blessing in disguise as it sometimes is much more than a storm in a tea cup. One moment water is scarce and shortly afterwards there is too much of it. And each crop has its own specific water needs. So more than 1,000 years ago the great shaping of the new delta started. Farmers took simple measures to control the water level on their lands. The problem in the Dutch delta was mainly a surplus. The paradigm now became *"drain the rain"*. Large areas of marshland were drained by the many ditches people dug to make the land arable. This peaty land decomposed and the result was a sinking land level. Our ancestors started a process which continues today. Other parts on high ground had to deal with water shortage. The solution here was irrigating arable fields. *"Manage the water"* became the next paradigm. Drain and conserve the water when it is available and use it to irrigate the fields in times of drought. All over the world large areas were deforested and cultivated. This reduced the ability of the soil to absorb water and, now unprotected, much of it was flushed away. A rough estimate has it that two thirds of the world's fertile fields have vanished over the last ten thousand years. The people in Nederland living near the sea and along the rivers needed to protect themselves from the rising waters. They started out by building "terps", artificial mounds. But that took time. Some Frisian terps outrank the pyramid of Gizeh in volume. And even the terps were not much help when it came to cultivating the land which was inundated by tidal waters. This is precisely the reason that rich gentlemen farmers constructed dykes around their fields from 1000 AD onwards.

The paradigm of that period was clearly *"protect man against the water and claim land from*

[1] A paradigm is a constellation of convictions, values and ways of acting that the members of a certain society have in common. In science it refers to the fundamental base of the ruling theory and practice in a certain field in a certain age. But notions tend to change with time. A change in paradigm can cause a revolution in a certain field. A phenomenon is seen in a completely new light. Paradigms are a key to the general outlook of an epoch.

seas and rivers". This was the era when "compartmenting" commenced. Land and water were divided into patches so that each could be managed separately. This had the advantage that each patch could be developed in its own sweet time. Compartimentation also made it possible to choose a different environment for each one, such as farmland, towns, salt water and fresh water lakes. But the sea and the river retaliated. This was the logical consequence when you box the water in with dykes. It had no other way to go than to go upward. This led to ever increasing height and width of the dykes, which in turn promised recurrent flooding of reclaimed land. Our nation has continually had to *"fight the water"* which is a leading national paradigm to this very day. It should be added, however, that this battle has never resulted in more than a tie.

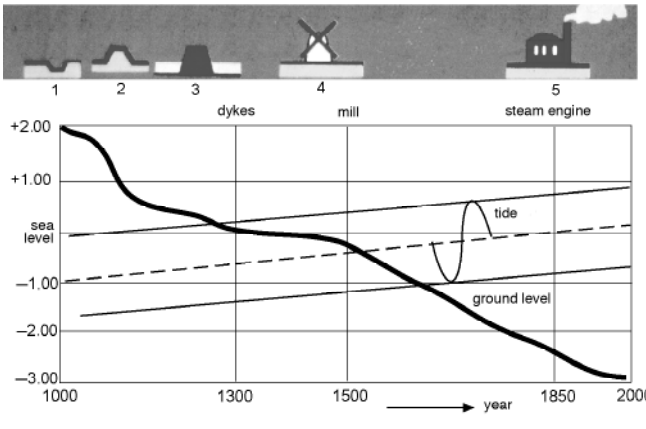
The 5,500 km^2 land that was wrestled from the sea's clutches in over 1000 years must be seen against the 5,000 km^2 that was lost again in the same period, according to Johan van Veen (an engineer and the spiritual father of the Delta plan). Turf and wind were the main sources of energy of our country. The peat digs led to new lakes, the "reclamation" of which started in Holland and Friesland some four hundred years ago using windmills. The paradigm there was: *"pump the lakes away"*.

Draining caused the peat and clay soil to become compressed, and the surface of the land to sink to below sea level. Consequently the drainage rate needed to be stepped up, which then resulted in the land sinking at an even greater rate, which could very well reach a level of a meter and a half per century (!). An important paradigm of those days is more valid today than most people realize: *"pump or perish"*.

Seepage of salt water under the dykes is jointly caused by the sinking ground level and the artificially low water level. Our soil was increasingly becoming brackish, a growing problem. Another paradigm of this age therefore was: *"flush away salt and control the water level"*.

Not only did the water quality suffer from salinity, but also the way household waste water was disposed of became a problem until the industrial revolution came up with solutions.

In the middle of the 19th century concern for public health triggered the construction of extensive sewer systems in the cities to get rid of the waste water. It was simply dumped into our surface waters without any attempt at purification. A new wet infrastructure was born which also dealt with surplus rain water. This relatively clean water was mixed with contaminated sewage and quickly disposed of. The paradigm of city dwellers and farmers alike was simply: *"get rid of excess water"*.



Picture 2.1 Sinking of ground level and rise in sea level in the lower parts of Nederland.

Developments now unfolded rapidly. The population exploded exponentially and the pace of technical and industrial developments went into overdrive. One of the consequences was a wave of pollution such as the world had not witnessed before, containing unnatural and often dangerous compounds. The scale of water management projects was stepped up. The salty Zuiderzee was enclosed to give way to the fresh water IJsselmeer. Rivers were transformed into navigable "roads" for ships, and canals were dug to connect them. In the sixties the main part of the Delta plan was completed, leading to the enclosure of most of the large sea inlets in the south-west Dutch Delta. The paradigm *"safety above all"* had taken root. Large scale human interventions in water systems was also seen in other parts of the world. In almost all of the world's main rivers dams, barrages and locks were constructed generously. To date over 40,000 dams are operational, a figure increasing annually by some 300. Man is filling many shores with constructions, and artificial islands are made in the sea to accommodate oil and gas extraction, city growth, harbors and airfields.

Water was regarded as something to sail on or as something to dump into. Quite often surgery in water systems was performed for one purpose only, such as normalizing streams to increase water flow, or dredging rivers to accommodate larger ships. But more often than not other useful functions of the water were lost. The paradigm of the sixties became: *"man has the exclusive right to the element water"*.

The seventies witnessed a shift of this tide. More and more people had come to realize that this unrestrained pollution of water must be halted, that man cannot continue to abuse it as a cheap container, a readily available diluting environment, a processor and a transporter of waste. The old paradigm *"protect man from the water"* became *"protect the water from man"*. The giant spring cleaning of surface water was getting under way. First organic compounds were dealt with, then phosphates and nitrogen, followed by heavy metals and organic micro-pollution such as oil, PCBs and more recently hormones. Those efforts have paid off, for the water quality had substantially improved since the sixties. But the legacy of pollution still haunts the water available to man.

In the seventies the value of salt water systems like sea arms and coastal seas gained increasing appreciation The Delta plan and the encapsulation of the Zuiderzee had proven that cutting off and allowing salt water systems to can be just as disastrous as pollution is. Instead of boasting healthy biologically rich and highly productive sea inlets that give us a marvelous holding capacity for organic prime materials, the seventies left Nederland with a bunch of overly fertilized, heavily polluted fresh water lakes. The vision that sea arms fulfill a valuable ecological, socio-economical and natural function led to the historical decision at the end of the seventies to construct a movable storm defense at the mouth of the Oosterschelde. This was much more than a compromise between safety and environment, it was no less than a new concept in water management and a clear break with the established trend.

One might think that the effects of pollution and the closure of sea arms are similar. Yet there appears to be a fundamental difference between serious pollution and poisoning on the one hand and the consequences of large scale constructions on the other. Whilst the consequences of pollution are only harmful, the construction of dams might lead to the development of new and valuable water systems.

This was also the era that a water system was regarded as more than a large basin of water, rather than as a living creature that has the capacity to develop in its own

Picture 2.2 Aerial photo of the Grevelingenmeer from a western angle. Schouwen and the Noordzee are in the background whilst the Stampersplaat is clearly visible in the foreground.

unpredictable way. Ecology made an entrance in water management. Water managers needed to become flexible and adapt their policies if triggered by developments in their systems.

The eighties acquired a new paradigm for water management: *"adopt and adapt the water systems"*. This new fundamental concept was applied in the development of the Grevelingen. At the time when this former sea arm was closed in 1971, intentions were to turn it into a new fresh water basin to support agriculture and to be used extensively for recreation. Halfway through the seventies it dawned upon us that a salty Grevelingen might be equally useful to society. Plans changed. The Grevelingen remained salt water, and recreation was concentrated at both extremes and in the south. Within certain areas nature was left to its own devices on the once submerged and shallow grounds. Only a few prior conditions were set, such as the salinity and the water level. This relative lack of control resulted in a number of surprises. Extensive sea grass fields were formed that shelter a rich community of flora and fauna. Water became crystal clear as crustaceans with filtering capabilities removed particles from the water. The famous oyster of Zeeland, which was diseased and snuffed out in other parts of the Delta, managed to survive in the Grevelingen.

Developments in the Grevelingen were a first experience with: *"adopt and adapt the water systems"*. The Grevelingen had also proved that water management can no longer be governed from a single field of interest only such as safety, agriculture or recreation but that ecological, economical and social aspects of a water system all are intertwined. The new paradigm became: *"integral adoption and adaptation of the water systems"*. A characterization of this approach is the close cooperation of different governing bodies and that public requirements are tuned to the possibilities that are inherent to the water systems themselves. This paradigm was first applied in the Oosterschelde. Policy was drawn up by all governing bodies and interest groups using the characteristics of the water

systems as a starting point.
The integral water system approach is still the basis of our present water management policy: It is the fundament of the Third Water Management White Paper, (Derde Nota Waterhuishouding) that was published in 1990, later amended in the Fourth Water Management White Paper.
Finally: what have we learned from our relationship with water in the course of history? Many different paradigms have succeeded each other. Still none of them has been completely abandoned, no matter how disastrous the consequences were. We are still pumping ourselves downwards and we still perceive water as an "enemy" against which we need to "battle". On the bright side it is clear that we have gained the insight that a fundamentally different approach to water is important.

2.2 Water, today's perception

In recent years the Dutch have been "surprised" again and again by disasters and near disasters that have to do with water, and have the potential to cause much damage and grief. There are many people alive today who still have vivid memories of the flood disaster of 1953, and who re-experienced those days when in the mid-nineties flooding occurred along the large rivers. There have also been many torrential rainstorms which have severely damaged crops. But in that same period Nederland was struck by drought and shortage of water. These are not isolated problems but symptoms of a disrupted water management that is based on wrong presumptions and has wrong priorities. What is our position now? What are the paradigms of the future? What barriers do we have to overcome? A thousand years of messing with nature's water management have left us with a number of gigantic problems. We can only understand these problems if we take into account the river basins of the large rivers as a whole, including all the land that drains into them, the estuaries and the seas they discharge into. The river basin of the Rijn starts in the Alps. As a result of climate changes, glaciers are melting at a rapid pace. This gives us a false sense of abundance, but in the long term, perhaps within 100 years, the Rijn will change from a glacial river into a rain river. Then the flow of water will be totally dependant on precipitation and the water supplies in the basin area.
In the basin area of Rijn, Maas and Schelde water management is still focused on getting rid of "superfluous water" as quickly as possible. Water level management is the prime consideration. Maintaining a buffer of water has no priority whatsoever. The level of groundwater is kept low both to support agriculture and to enable sewage systems to remove water from the cities quickly. Groundwater is tapped on a large scale for drinking water and industrial purposes and in dry periods it is used to quench the thirst of the farmers, without any of these natural stocks completely being replenished. Overexploitation of groundwater in combination with deforestation lead to a decreasing capacity of the soil to absorb water. A consequence of this is a lack of water in times of drought. Then it proves necessary to use costly means such as piping to transport water from the reservoirs.
Shortage of water will periodically saddle us with problems in agriculture, will restrict floating traffic and will prevent adequate cooling of nuclear power plants, whereas in wet times the rivers will need to cope with enormous masses of surplus water.

The rivers themselves have been shortened dramatically (the Rijn by 40%), have been crammed with dams, locks and barrages. They have become narrow by poldering the river forelands. During peak periods the only direction left to the water is up, increasing the risk of flooding and necessitating making the dykes higher and higher. This became all too clear when in the nineties many large rivers overflowed their banks.

Estuaries are extremely useful to man in their natural state. They cope with the abundance of nutrients such as phosphates and nitrogen which stem from agriculture and industry. They transform these otherwise waste products into products beneficial to man, such as fish and shellfish. But the Dutch have closed off most of these estuaries to the sea. Exceptions are the Westerschelde which has remained open for sailing traffic, the Eems-Dollard and to a lesser degree the Waddenzee.

All other locations show a complete separation of fresh and salt water by dams and locks. This separation has blocked the natural holding capacity and the large productivity of these systems, leaving our coastal waters with a surplus of nitrogen and phosphates, and rendering them completely disrupted and ineffective in their cleansing function.

When it comes to the division of the scarce product called "space" water managers are still consulted far too late in the process. This delay has contributed significantly to the completely illogical way Nederland has become "organized". The main share of all invested capital still takes place in the deepest part of the country, the Randstad. New housing estates continue to be developed in the deepest of polders (like Rotterdam's Alexanderpolder) and it looks as if future investments will continue to be made in the polders of Zuid-Holland. These polders with their peat substrate are quite unfit to do the job required of them. Urbanization will necessitate lowering the water level, forcing us to pump ourselves down even faster. A distressing problem which is closely related is the rise of the sea level. Global heating as a consequence of the greenhouse effect (+6°C) is causing the polar caps and glaciers around the world to melt. That in itself might cause an additional rise of the sea level by a maximum of 90 cm, which cannot but have the most dramatic of consequences for low coastal areas like deltas. Nederland especially is vulnerable to such a rise in sea level as the most densely populated and industrialized areas are at the same time the lowest ones. And as already noted, we are diligently pumping ourselves down in this substrate of peat. Even large parts of the relatively young Flevopolder have experienced a sinking of the ground of over 45 cm simply because of current water management. And since the levels in the Oostvaardersplassen are kept high, these lakes will eventually end up being higher than the surrounding polderland.

Coastal safety is a source of constant concern. Even though the sturdy dykes and dams exude a false illusion of safety, there is a real chance of actual flooding. There is no such thing as 100% guaranteed safety. The quality of water defenses needs continual upgrading, or dykes and dams need to be replaced entirely. Reserving the required space is crucial to this process.

And space will become a scarce commodity indeed, the more so because recreation along the coast has grown at an explosive rate and most people prefer to live on or near the coast.

The tendency of water problems to cross national borders doesn't always help in solving them. This is especially true when the interests of the countries concerned differ widely – as is all too frequently the case. Take, for example, Nederland. Positioned down-

Picture 2.3 Simple pumping station.

stream, its water management aims at safety, water quality and multiple use of water. Switzerland, on the other hand, situated near the source with a tremendous supply of water, focuses on water quality, recreation and hydroelectric power.

Both countries aim for water *quality* so it will be relatively easy to get them to see eye to eye on that aspect. But water *quantity* is a different ball game. Here the interests often oppose each other. In dry periods upstream countries will want to hold the water in artificial lakes – with the risk of a shortage of water in the Dutch delta. In wet periods, with water in plentiful supply, upstream countries will release their reserves, leading to an excess of water in the Dutch delta.

Such problems play their roles in all river basins spanning multiple countries. But if the problems are not addressed adequately the inhabitants of these river areas run great risks of being confronted with floods, lack of sufficient attainable water and loss of land for agricultural purposes.

Areas with an exploding population are heading for famine and serious conflicts about water, with all the concomitant social consequences. For many countries this bleak scenario has already become grim reality. It is irresponsible to approach these problems by simply shrugging one's shoulders and muttering "doom thinking" under one's breath, or to ridicule the problems by pointing to solutions technology offers. There are many cases where technology will ease the pain, but in many other cases the solution must arise from a drastic change in fundamental mindset as to how to deal with water.

Such a revolution needs to be supported by the population and their politics, and more often than not this commitment is simply absent. So the key question is: "How to continue?"

For starters we need a different approach to thinking about water. Water still has a bad image: it is the enemy we must fight. Problems are aired extensively, conveniently forgetting that they were usually caused by our own unwise or careless behavior in the past.

The blessings that water bestows upon us are considered our natural (and preferably

Picture 2.4 The level of the polder lays 4 meters below the level of the river.

Picture 2.5 Water mills and the 'inverse' landscape.

free) birthright. It is about time that we realized that we owe water not only our lives but also our prosperity. Water deserves a much higher place on our political agenda. To achieve this we need to map out its assets as well as its liabilities. It would be a great help if we could visualize all services and products that are connected with water systems and possibly express it in cold cash (see Essay 9). As a case in point, if the natural purification ability of the Dutch river estuaries had not been hampered by the Delta plan, then many of the costly measures to obtain a reduction of phosphate and nitrogen in the air would not have been necessary. It is also quite reasonable to suppose that closing off sea arms has led to a substantial loss in production of coastal waters. And what

would it cost the agricultural sector if pumping up groundwater were no longer free? On top of that billions of Euros are reserved for the construction of new (rail)roads, and industrial and dwelling estates in western Holland without taking into account the cost of the foreseeable result of ground sinking.

As a final example let's take a look at the city of Arnhem in eastern Holland, straddling the Rijn. If Arnhem wishes to expand into the river forelands, dyke fortifications are needed downstream. These may cost more than the city expansion will yield, but those costs are currently not part of the equation. All these examples teach us this one crucial lesson: if the loss of the natural functions of water were to be priced fairly, many projects would not take place simply because of the enormous monetary loss. This applies to both planned projects as well, of course, as past projects, the legacy of which we are now challenged to deal with.

Moreover we must be more than ever aware of the fact that all projects undertaken to solve problems of just one sector might have dire consequences for other sectors and for nature. Closing a sea arm might be beneficial to safety but is a disaster for the fishing industry.

The "sector approach" to problems must be replaced with an integral one. All operations performed on water systems must be judged against considerations involving all the water's functions, and whether these hold true, both now and above all in the future.

An aspect of "water-scaping" is the responsibility that different departments have for this common interest. Because water is also an important part of the policy in various fields such as agriculture, nature, environment and spatial planning, it is essential that different departments and ministries closely together. This is equally true of international cooperation. When a river flows through different countries, these countries have a joint responsibility for its water management. As already discussed, constructions upstream might after all lead to grave consequences for the countries downstream.

Lastly, but most importantly, we must learn to respect the laws of ecology and put them to good use. A vital step in this direction is adopting the approach of water systems as our primary consideration. It is the only way we can restore our water systems to a healthy, clean and well functioning condition without running the risk of droughts or floods. Which brings us to the paradigm of the future: *"eco-pragmatism",* in other words acting pragmatically and specifically guided by ecology and laws of nature to the benefit of man *and* nature.

The water systems themselves should be firmly at the heart of all considerations, their processes, the interaction and what can be technically achieved to improve them. Society must learn to base its wish list on what is attainable according to those conditions.

An example of applied eco-pragmatism is the development of the artificial lake called *Grevelingenmeer*, where only a few ecological conditions were set, such as desired salinity and water level. In all other matters the policy was kept flexible and adjusted according to real-time field findings and ecological models. In this way a "dialogue" took place between the water and its manager, who in the process started to understand the ways of Mother Nature and what he might do to help.

This form of management might be labeled *guided ecosystem development*, and can best be compared to the raising of children. Parents (the managers) determine the parameters according to which guide the child (system) is allowed to develop. The final result can

only partly be predicted and also depends on the qualities within the child. Early and vulnerable stages require protection, but the child must also develop internal strength and that requires new and sometimes bold steps on the road to adulthood. And just as when we raise our children, eco-pragmatic management aims to stimulate the development of dynamic and resilient water systems that are capable of performing the functions required of them.

This type of management offers generous opportunities for surprises that nature might have in store for us. There must also be room for functions that might not readily be expressed in monetary terms. Water systems should be meaningful to society, interesting and multifunctional. By the way, this also means that not every healthy functioning ecosystem must be given the status of national park! A healthy, well functioning ecosystem should be the rule rather than the exception. Laws of Nature apply everywhere, be it recreation, fishing grounds, harbors or natural parks.

All these new insights have in the meantime penetrated the mindsets of policy makers. There is a flood of new policy descriptions with picturesque names such as "Coast on Course", "Water in the City" and "Space for the River". But this flood of colorful descriptions of policies still bears too little resemblance to actual practices.

Politicians still tend to work in a compartmentalized way and resort to technical rather than ecological solutions. Those technical solutions might be able to relieve a problem in the short run, but could eventually become a problem of their own. To cite a simple example: the construction of more and bigger pumping stations apparently solves short term issues, but as already elaborated leads to extensive long term problems. Large sums of money continue to be invested in roads, railroads and industrial sites, and at the same time not much of it is available for integral water management.

At most money is budgeted for a project in one isolated sector, such as a nice new wet recreation area. It would seem that we fail to convince the general public and politicians with simple arguments. It isn't easy to break through a centuries' old tradition of gaining land, fighting the water and "pump or perish".