Presentation in Nagoya 11-2019

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I feel very honoured to be invited to tell you about our experiences with water management in the delta area of the South West of the Netherlands. In my introduction I will show you what the ecological drawbacks are of building dams in an estuary and how we try to solve these problems.
My name is Tjeerd Blauw. Till 2014 I worked for the Government of the Province of Zeeland, part of this Delta area, and as such I was involved in the policy planning for this area.
That is why I like to share our experiences with you.
First I like to show you where I come from.
(2), (3), (4)
I am happy to be here, because we have something in common, or better said: we have someone in common: (**5**) Johannis de Rijke. He was born 1842 in Colijnsplaat, (**6**) a village not far from my home in Middelburg.

Almost 150 years ago he came to Japan to work as an engineer to prevent rivers from flooding. He worked also in this area. On the Nagara River, the Ibi River and the Kiso River.

There is a certain similarity between this area and the area where I come from: three rivers come together and flow into the see. (**7**) In the area where I come from these are the River Rhine, the River Meuse and the River Scheldt. Together they formed the Delta Area of South West Netherlands, between Rotterdam and Antwerp in Belgium.

(**8**) This is a closer look at the area. In de north Rotterdam, in the south Antwerp.
This area not always looked like this. (**9**) From the last ice age /glacial period till 1000 years ago this area was covered with mainly peat and salt marshes. People had to adapt themselves to the natural forces.

From about 1000 years ago people started to build dikes to protect themselves and to conduct agriculture. The landscape changed considerably. (**10**) As you can see here, the whole region now consists of a network of dikes.

Dikes can protect but can also collapse. Especially in the past when engineering techniques were weakly developed. Therefore it is not surprising that many flood disasters occured. (**11**) Here you see the main floodings since 838

(12) In 1953 a large and till now the last flood disaster happened in the Southwest of the Netherlands. More than 1800 people died.
The National Government decided to execute the Delta Plan.**(13)** One of the goals of this plan was to shorten the coastline with more than 700 km by building dams. Only in the North and in the South no dams were built, because these are the waterways to the harbours of Antwerp and Rotterdam.
Haringvliet was not closed by a dam, (14) but with sluices, that are open during low tide to let the water of the rivers Rhine and Meuse flow into the North Sea. During high tide the sluices are closed to prevent seawater from flowing into the Haringvliet. In this way the Haringvliet was made a freshwater reservoir.

Before we built the dams there was a transition zone between the rivers and the sea. It is called an estuary, a dynamic and productive environment with tides, changing river flows and salinity gradients.
The Delta works transformed the estuary into separated water basins. The dynamics of the estuary almost completely disappeared fromthe area.

(15) The original plan was to build solid dams between the islands and to create a large freshwater lake behind these dams. This freshwater should be used for agriculture.
During the execution the plan has been changed several time and the concept of a large freshwater lake slowly disappeared.

In the sixties of the last century environmental awareness arose. There was a lot of protest against building a dam in the Oosterschelde. A coalition of fishermen and environmentalists feared the disappearance of the valuable saltwater ecosystem of the Oosterschelde, famous for its Oysters and Mussels. (**16**) In the seventies the government decided not to build a dam, but a storm surge barrier, that only closes when very high water levels are expected at the North Sea.
The result of this: the Oosterschelde stayed a tidal saltwater system.

(17) North of the Oosterschelde a dam was built separating Grevelingen from the Northsea**(18)**. In the eighties it was decided to keep the Grevelingen Lake salt because of its valuable saltwater ecosystem and the recreational value of the lake.

1997 the Delta project was finished. **(19)** Here you see the final result. Only the VZM and the HV are freshwater systems.

As time passed, it became increasingly evident that elimination of the dynamic processes of an estuary has ecological drawbacks. Lack of exercise and motion is unhealthy for people. Similarly, eliminating or reducing the dynamic interplay of an estuary also causes all kinds of unhealthy situations. Each of the Delta water basins suffers from problems that can be traced down to the disappearance of the dynamic processes of the estuary.

Basically the focus of the Deltaplan was on water safety. That is understandable considering the catastrophe of 1953. But in retrospect it should have been better if also other aspects of water were taken into account. With other words integrated water management should have been better than sector-focused water management.
(20) Water is not only an enemy, but also a friend. We have to protect ourselves against the water, but we also have to realize, that we need the water. For nature, for economy, for every aspect of our live.

The only thing we can do now is to repair the drawbacks. I will give you a short overview of these problems and the way we try to solve them.

As I told already each of the Delta water basins suffers from problems that can be traced down to the disappearance of the dynamic processes of the estuary.
The dynamics of estuaries can be characterized by several aspects. Some are shown here **(21)**. (Involving nutrients, river and tidal flows, salinity gradients, morphology etc.)
For (almost) every aspect of the estuarine dynamics we can find a water basin in the South West Delta area where the loss of that aspect causes an ecological problem. For most of the problems the solution is to partly bring back the dynamics of the estuary.
Bringing back the tides implies, that the salt concentration of the water will increase. This is a problem when the freshwater in the lake is used for agriculture. If this is the case, we have to create an alternative way to supply freshwater. We do this by replacing the inlet to a place more upstream, where the river water is and will stay fresh.

1. Nutrients.
   In the original estuarine situation, nutrients – as they flow from the

river to the sea – are gradually converted into algae, zooplankton, bottom-dwelling invertebrates, and shellfish, which in turn served as food for populations of fish and birds and us. However, in a stagnant lake situation, excess nutrients lead to excessive (blue-green) algal blooms.

a. (**22**)Lake Veere. After building the Zandkreekdam and the Veerse Dam this newly created lake turned out to be a brackish lake with high nutrient loads from the surrounding agricultural land and a long retention time of the water because of the disappearance of the tides. The results: algal blooms and anoxic bottomlayers. **(23)** The solution: in 2004 a new connection between the lake and the tidal Oosterschelde was built. **(24)** Lake Veere changed from a brackish lake into a saltwater lake with (small) tides and short retention time. **(25)** Nutrient concentrations decreased **and transparency** increased. We see no algal blooms anymore and restoration of the saltwater ecosystem.
b. **(26)** Another example of this nutrient problem is Lake Volkerak-Zoom: a non-tidal stagnant freshwater lake with heavy nutrient loads and a high water retention time. The result: (**27**) heavy blue-green algal blooms making the lake unfit for recreation. We found out that the only way to solve this problem is to make this lake a salt and tidal lake again. Salt: to prevent the growth of blue greens; tidal: to prevent stratification. The freshwater of the lake is used for agriculture. So we first have to create an alternative freshwater supply. **(28)** At this moment parts of the alternatives are being built. The inlet of fresh water will be dislocated to a place upstream. At the same time we see a light improvement of the blue green algal situation and the development of valuable freshwater nature. So at this moment there is a discussion: Why should we make the lake salt? A lot of fierce discussions at this moment. Till now the future of this lake is unclear. We expect some clarity from the national government at the end of this year.

2. **(29) Hydro-m**orphology
   Oosterschelde: Since we built the Storm Surge Barrier smaller quantities of water are flowing in and out.
   The tidal channels are too large for these smaller quantities of water. Natural processes to reach a new dynamic equilibrium are therefore reshaping the morphology of the basin. **(30)** In this process, valuable areas of mud flats, salt marshes and shoals are disappearing and

eroding as bottom sediments are redistributed to fill in the deeper channels.
These tidal areas are very important for birds and seals. We found out, that the only solution for this problem is sand replenishment. The first pilot's show that this solution works. At this moment we execute a program for sand replenishment of the Roggeplaat, a shoal just behind the storm surge barrier. 1,3 million cubic meter sand will be put on the shoal. This started the first of October and will be finished at the end of December.

3. **(31)** Vertical mixing of the water. The tidal energy in a natural estuary prevents stratification. But in Lake Grevelingen: despite of the existing small connection between the lake and the North Sea there are problems. The tidal energy is too small to prevent stratification of the lake, resulting in anaerobic bottom layers **(32)** These layers are growing every year. **(33)** Under water it looks like this: above 4 m water depth it is OK, but below 4m it looks terrible. Neither fish nor shellfish can live here. The recreational value and the value for fishery is endangered. The only solution is a bigger connection with the North Sea. **((34)** A computer model predicts that the problem of oxygen depletion is almost completely solved then. The national government promised 75 million euro extra to build this connection**. (35)**Probably before the end of this year a decision will be taken about the plan to realize the connection and eventual the tidal energy plant. The connection should be ready in 2026
4. **(36)** Salinity gradients.
   In natural estuaries there is a salinity gradient from freshwater in the rivers to a salinity that equals the salinity of seawater. This gradient makes it possible for fish to migrate from the sea into the rivers and from the rivers into the sea. If this gradient is changed into a sharp transition between seawater and river water migration is impossible, because fish die from the osmotic shock.
   (37) Haringvliet sluices worked in one direction. River water could flow out into the North Sea, but seawater could not flow into the Haringvliet. There is a sharp transition from seawater to river water, which makes fish migration almost impossible.
   It took more than 18 years to decide to open the sluices a little bit in order to create a salinity gradient in the Haringvliet allowing fish to migrate from the North Sea into the rivers and vice versa. It took so long to convince farmers and industries that the salinity gradient can be managed and to realize the alternative freshwater supply**(38)** Saltwater is not allowed to come to the freshwater canal to the harbour of Rotterdam. Freshwater inlets in the zone between the

sluices and the canal are removerd to a place upstream.
Finally with some pressure from the European government level the government decided to open the sluices a little bit. At 15-th of November last year the minister decided that the sluices can be put ajar. But because of the low river water flow it took till 16-th of January, before one sluice really was left ajar.
(39) Since then an implementation period started. This period can be characterized as a step by step careful testing of the salt distribution in relation to the management of the sluices. “Step by step and careful” because it is very , very important that the freshwater supply for agriculture and industries is not disturbed.
In periods of low river water flow the sluices have to be closed. Before that closure the system has to be flushed with freshwater to remove all the saltwater from the system. This will be tested in a series of flushing scenario’s. The first test learned that flushing is effective at riverwater discharges above 3500 m3/s. Next test will be flushing at lower discharges. In this way knowledge will be collected about management risks in order to fine tune the management of the sluices.
At the same time a program started monitoring migrating fish species. Also other ecological aspects will be monitored.
(**40**)In this way we slowly and careful will open the front door of the River Rhine and the River Meuse for migrating fish.

Summarizing:
The lessons we learned from the drawbacks of the Delta works are (**41**)

- that almost all ecological drawbacks of the Delta works can be solved by bringing back the estuarine dynamics.
- that it is better not to approach an issue only in terms of safety or agriculture or water quality. A shift is needed from this sector – focused water-management to integrated water management that integrates all relevant aspects, including ecology and economy. With an integrated, comprehensive approach drawbacks of the Delta works could have been avoided.
- that ecosystems are complex. The consequences of interfering into these complex systems are not always known beforehand. That is why Henk Saeijs, founder of the concept of integrated water management, said once:
- (**42**)Nature is the best engineer. Think twice before you interfere.

(43) Thank you for your attention