

B. Biogeomorphology

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1. Interview with Dr. M.M. van Katwijk



Coastal river, sediment transport, salt marshes and plants

Dr Marieke van Katwijk tells us about six different studies that fall under the LOICZ theme Biogeomorphology of coastal zones. These are innovative studies because different disciplines are collaborating together and new equipment is being used.

Two of the LOICZ studies focus on geomorphology, but their studies have biological implications. These concern the coastal river that determines how the sediment and nutrients are transported along the coast and how much sediment enters the Wadden Sea. The other studies focus more on the biological aspects in interaction with geomorphology. They mainly concern the accretion and erosion of salt marshes and seagrasses.

Coastal river and sediment transport

Van Katwijk: The first study by Gerben de Boer (Deltares) is about sediment transport and the nutrient flows just off the North Sea coast. Between Hook of Holland and Den Helder a “river” flows at a speed of 20,000 m³ per second, which is comparable in size to the Mississippi. This river is a continuation of the Rhine. The water in the coastal river is frequently stratified: the surface is often fresh but the floor salty. At the Marsdiep, the water and sediment enter the Wadden Sea. A model of this has now been developed by Lucas Merckelbach (NIOZ) that gives us an understanding of sediment transport along the coast and in the Wadden Sea.

How exactly can we measure sediment transport into the Wadden Sea?

A device was attached on the Texel ferry, a so-called Acoustic Doppler Current Provider. This is a cheap technique that allows us to measure the suspended sediment in the Marsdiep. Merckelbach calculated that about 7 million tonnes of sediment enters the Wadden Sea, a figure 5 to 10 times higher than previous models had calculated.

Salt marsh rejuvenation

Salt marshes are important for the Dutch coastal defences. When a large salt marsh is located in front of a dike, the dike needs less enforcement, which is cheaper. Wherever possible water management policies look for natural solutions in addition to elevating and strengthening dikes. Salt marshes provide a very subtle piece of coastal defence.

Due to a range of interventions and changes in water management, these marshes are disappearing. And once they have gone, re-establishing them is anything but easy. Erosion often starts that the edge of the marsh, and cliffs may form. Once a cliff has formed, the erosion accelerates. To prevent cliff erosion, it is important that the foreland is relatively high, so that wave energy has already attenuated substantially when it reaches the marsh edge. Therefore this foreland, the intertidal flat, is of importance. If sediment accretes in the intertidal flat, and this zone can keep up with sea level rise, the risk of cliff erosion reduces. In the intertidal flats, seagrasses, oyster and mussel beds are typical ‘ecosystem engineers’ that can stabilise and accrete sediments. The LOICZ-programme had two projects on salt marsh dynamics (van Wesenbeeck NIOO and de Groot RUG) and two on seagrass dynamics (Van der Heide RUN and Dijkstra TUD), all four focussing on interactions with sediment and hydrodynamics. The results of the projects have, amongst others, been used for further research that is funded by the innovation fund Building with Nature, which supports solutions in water management that work with nature rather than against it. In this research

That sounds fantastic. Building with nature seems to be a natural, sustainable and above all cheap form of coastal defence.

That's right, but remember that these processes are all very subtle, and we will remain depending on the hard engineering solutions for our coastal protection. All ecosystem engineers in coastal zones, like saltmarshes, seagrass beds, mussel and oyster reefs can come and go, they are typically dynamic. The restoration of *Zostera* fields is a thing of the future, as these fields are still disappearing and do not seem to recover by themselves.

*Why does *Zostera* fail to re-establish itself in the Netherlands?*

There is no simple answer to that question. *Zostera* is continuing to decline in The Netherlands. At some locations it might be due to the activities of lugworm diggers, and at other places it might be the consequence of successive cold winters. Because the causes differ per occasion, we suspect that there is some underlying cause that reduces *Zostera*'s ability to recover. It undermines its health, so to say. We suspect that one possible underlying cause of this is eutrophication and the other a changed salt concentration due to a range of interventions in the water management. The changes are taking place so fast that *Zostera* can no longer adapt to these. In some parts of the Wadden Sea the salt concentration is too high, whereas at other locations it is too low. In the Oosterschelde and Lake Grevelingen, the salt concentration has increased during the 1980s and 1990s.

What can be done about this?

Re-establishing the *Zostera* could be the first step towards restoring the salt marshes. Perhaps we ought to consider introducing *Zostera* races from neighbouring countries that are more salt tolerant. Yet that would meet countless objections due to the import of foreign material. It would not be a realistic option under the current nature policy. However, in the Oosterschelde we must act soon as the sand is disappearing into the channels and there is a constant demand for sand. As *Zostera* re-establishment is not feasible in the short term, there are presently experiments with the creation of oyster banks in the Oosterschelde. For experimental purposes we will also try to replant local *Zostera* species there. This is a follow-up study that does not fall under the LOICZ. Nevertheless, the LOICZ studies were highly inspiring for the different research groups. Indeed the effect was so great that six follow-up studies are now in progress, largely funded by the Building with Nature programme: not only the oyster bed creation and seagrass mitigation in the Eastern Scheldt, but also mangroves in Singapore, coral reefs and seagrass fields in Thailand and so forth.

Now we are jumping too far ahead. Back to the studies about salt marsh rejuvenation carried out for LOICZ.

One study focussed on determining the sedimentation patterns and spatial processes in salt marshes and tidal flats. Sedimentation patterns are complex and change with the age of the salt marsh. A method has been developed to map the salt marshes using natural gamma radioactivity. Now these accurate measurements can be used to assess the impact of shell fishing and seabed subsidence on the tidal flats. Furthermore, the results serve as a reference point for the natural

dynamic processes that occur there and this information is extremely useful for the Water Framework Directive, Natura 2000 and Dynamic coastal management.

And then there are also the studies into the interaction of various plant species with the sediment.

On a small scale, positive interactions can take place in the pioneer zone of the salt marsh and on a larger scale negative interactions. Plants support each other on a small scale but if such a tussock becomes too large, a channel develops around it which leads to erosion. The tussocks then become a sort of wall that the waves crash against. This results in negative feedback. The larger a tussock of *Spartina* becomes, the greater the negative feedback. That is sometimes referred to as mechanical warfare. Scale-dependent feedbacks give rise to certain patterns. Interestingly, the same complex feedbacks and mechanical warfare that were found for salt marshes were also discovered for seagrass in the LOICZ studies. Now we know how those processes occur, we can do more to facilitate the rejuvenation of salt marshes. And by doing this we indirectly contribute to the natural strengthening of dikes

And so we have come full circle back to dike strengthening and coastal vegetation...

Indeed.