CHAIR OF THE BIOLOGY DEPARTMENT AT UNIVERSITY OF ANTWERP PATRICK MEIRE

‘HOW CAN WE CHANGE OUR BEHAVIOUR AND ACTIVITY TO WORK WITH THE ECOSYSTEM **RATHER THAN TO DESTROY IT?’**

Guided by an expertise in biology, Patrick Meire remains dedicated to understanding the delicate and intertwined estuarine ecosystem of the Scheldt which has been increasingly threatened by human activities and sea level rise. Turning research into action, he helped design a flood control area in the polders of Kruibeke, Belgium alongside garnering communal and governmental support over a 25 year span to make it a reality. A joint research project of Greenland’s melting glaciers is further evidence of his environmental passion and dedication to future generations.

What is your academic background and how has it impacted your work today?

I studied biology and spent most of my research career on studies of estuarine and wetland systems. I started the research for my PhD with a study on the impact of the construction of the storm surge barrier in the eastern Scheldt on the benthic invertebrates and bird populations. At that time, in the early 80s, the main focus of the study was assessing the impact of human activities on the environment as it was obvious that the storm surge barrier would have quite some negative impacts on the ecosystem of the eastern Scheldt. Gradually as time went on, my work changed from studying the impacts of human activities on the environment to see how human activities could *improve* the environment. That was the change towards the concept of restoration and how we can do things in a better way for the environment, or even enhance the environment.

In this way, I've developed very much from the early days where I was studying how oystercatchers were feeding on mussels, so doing very detailed feeding ecology studies focusing on just a few species. My interest gradually grew towards looking at the whole system and that's now also the strength of the work that we are doing. It's not just focusing on one detailed aspect of an ecosystem but trying to have a more holistic view of the different aspects and how the system as a whole is really working. Over the course of my career, it's quite a big development that I was lucky to be able to make and it was also very exciting. This also makes it very difficult, people say I'm a physical oceanographer or a wetland ecologist or a benthologist or something like that. For me, I feel more like an ecologist linking different things together and looking from the system's perspective to understand: how is the system working?, how are the interactions between human activities and the system?, and how can we change our behaviour and activity to work with the ecosystem rather than to destroy it?

The link between science and application and management is a very important point because we do science to improve the world.

It is a very clear choice that my research group ECOBE is called Ecosystem *Management* Research Group because the link between the fundamental science and the management, the more applied science is extremely important to me. On the one hand it is essential that we do fundamental research and look into new directions, so researching topics which do not immediately have a link to the application. But on the other hand, at a certain moment, we must look for the link between the science and the application. The link between science and application and management is a very important point because we do science to improve the world. We must try to use the best of the science to manage the environment. That is, at least for me, a very important thing.

What was your role in bringing Ecosystems Services to the fore?

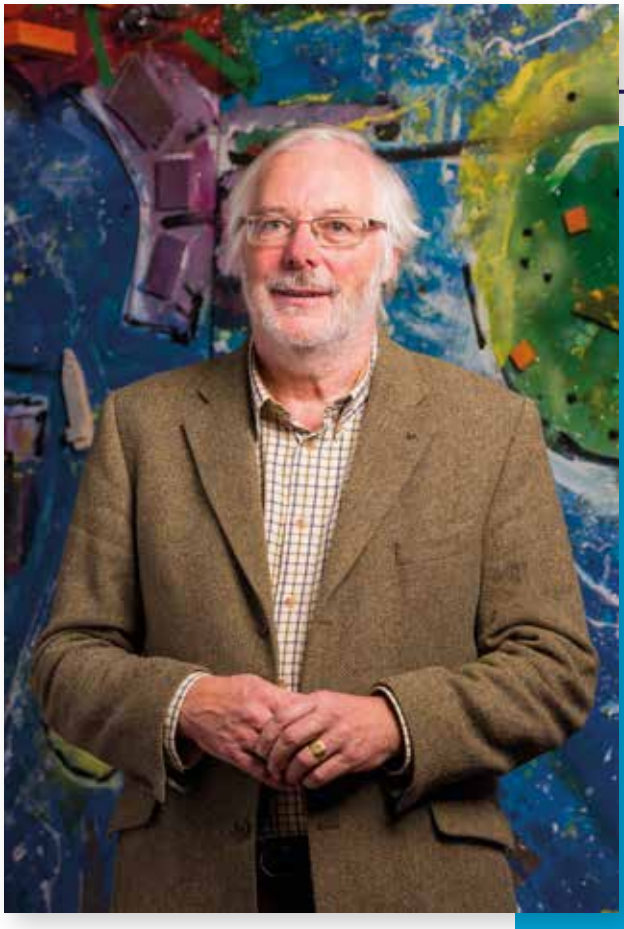
We wrote the first report on the ecosystem services (ES) of the Scheldt estuary in 2000 when the concept of ES was still poorly known. Ecosystem services are the direct and indirect contributions of ecosystems to human well-being. It was only three years earlier, in 1997, that the very influential paper *The value of the world's ecosystem services and natural capital* by Robert Costanza and co-workers was published in *Nature* and it was not yet very well-known at that time. The Millennium Ecosystem Assessment – a next very important step forward in the concept of ES – was only published in 2005. Since our report in 2000, I'm sure that the concept has greatly helped in convincing people of the importance of trying to change our way of managing estuaries, wetlands and coasts by taking more into account the values of ecosystems, and understand how ecosystems are important to us as human beings. The report *Ecosystems Services: Towards Integrated Marine Infrastructure Project Assessment* – made in collaboration with IADC and released in 2016 – has certainly contributed to spreading the knowledge and the ideas of the concept of ES within the dredging community.

In essence, the concept of Ecosystems Services is nothing new, it is mainly a way of presenting fundamental knowledge. If you have an ecosystem service like waste water treatment – the removal of nutrients from your system – that's pure ecology and has been studied for a long time. The crucial point of ES is translating all of the scientific knowledge into something which is understandable for a broader audience and which also links to human uses. In that way, indeed we have been embracing the concept since the beginning of the year 2000 when we wrote the first report on ES in the Scheldt estuary, as a concept which brings the fundamental knowledge of the functioning of the systems to a broader audience and to a lot of different stakeholders. The latter was very important in finally managing our ecosystems like estuaries because there are ports, fisherman, people for recreation, and a link with agriculture. All of these people are stakeholders and you have to bring them to the level of understanding of the system. ES was a crucial tool for doing that.

Can ES provide incentive to those with only economically-driven motivations?

For sure. There are two very important things. First, there is mitigation which means reducing emissions of greenhouse gases. That's mainly a technical issue where we have to change to renewable energy although also ecosystems can play a very important role as a sink for carbon. Next, there is adaptation. Temperature will rise, precipitation patterns will change and the sea level will rise. How much will depend on how far we go with mitigation but these changes will happen and impact our society. Adaptation are those measures we must take to reduce the negative impacts of climate change. This is very important and in my opinion, ES should play a crucial role in adaption strategies because it gives the possibility to come to multiple objectives.

An essential objective of Environmental Management will be to implement adaptation strategies in which natural habitats play a crucial role. As this will create multiple benefits by delivering ecosystem services that represent a large economic benefit this becomes interesting to those with only economically-driven motivations. We can restore wetlands such as peat lands



Meet Patrick Meire

While obtaining his PhD in biology from University of Ghent, Patrick Meire was dedicated to researching the impacts of human activities on ecosystems. His interests evolved, expanding from merely understanding these impacts on ecosystems to include an active role in reversing them. Alongside his roles as chair and professor in University of Antwerp's biology department, he frequently contributes knowledge through scientific publications, coordinates the OMES project that monitors the environmental impact of the Sigmaplan within the Scheldt estuary in Flanders. The latter is a decades-long initiative to ensure the area's safety against flooding as well as enhance recreational, natural and navigational resources.

and coastal marshes. All of these are very important for storing carbon so by recreating these habitats, you can create a carbon sink. When plants take up carbon for growing, part of that organic matter is stored in the soil and kept there for a very long time, acting as a sink for the carbon in the atmosphere. Forests do the same thing but wetlands are especially effective as carbon sinks because there is a wet condition in the soil that keeps the organic matter from mineralising and therefore remains in the soil for a very long time.

While there is the issue of storing carbon on one hand, on the other hand, tidal marshes or mangroves play a crucial role in attenuating waves from storms or hurricanes. By creating these habitats, society can be adapted towards climate change by reducing impact of storms and storing carbon. The concept of ES can bring a lot of ideas for the adaptation of society and the environment towards climate change. Having multiple objectives and understanding what these habitats can deliver to human beings is the most crucial thing, and will help to motivate people to invest in these measures.

Do you believe the dredging industry can make a difference in improving the environment's quality?

In the past, the dredging industry destroyed a lot of the environment by dredging, altering coasts and building huge constructions along the coasts. At that time, the considerations for the impacts on the environment were not important but people within the dredging industry started to understand the consequences of what they were doing and saw it could be very significant. As an industry, it is important to take into account these negative consequences of what is being done. The concept of Ecosystems Services gives the possibility to not only look to the negative consequences of certain works but to look to the possibilities, adapting and changing the planning to not only have the classical economic benefits but in fact to make the projects in such a way that there is a much broader societal benefit. That's, I think, very important and I am quite confident as time goes on, the importance of creating an overall societal value – and not just access to a port or having a container terminal – will become very important and also a crucial factor for the dredging industry. I would even go as far to say that this vision will be essential for successful continuation of the industry.

It is a matter of objectives. If we talk about twenty years ago, access to the port was *the* objective. Just dredge the fairway so that ships with such a draught can reach the harbour and dump the sediment in the most economical way more or less independent of the impacts on the system. In this way, dredging and the placing of dredged sediments can become a crucial management option for sustainable use and management of estuaries but this requires a holistic view, and the concept of ES must play a crucial role in this.

The book *Dredging for Sustainable Infrastructure* addresses the topic of beneficial use of dredged sediment. Can this resource improve environmental quality?

For instance, all the estuaries along coasts are confronted with erosion. Some of the experiments that are going on now are to see how these sediments that are dredged

in one place can be used to enhance the morphological development of another place. The sediment can be used to prevent erosion and keep the system in place. In the Scheldt estuary, there are several examples of what is called 'morphological dredging' where sediments are placed where there is erosion. And you can see how the sediments are being transported by the currents to the tidal flats. There is also the example of the Sand Engine in the Netherlands which is a similar idea although not related to access to a port but to safety and maintenance of the coastline. The Sand Engine is also a nice concept which combines these different aspects and also makes use of the forces of nature.

When multiple objectives are created for a project, it is no longer only about having a fairway to the port. It is having a fairway to the port *and* maintaining the morphology in the system that also helps to maintain the hydrodynamic characteristics which are also important for the morphological aspects. Then a whole series of objectives have become important and can have a much bigger societal value than just access to the port.

In that way, I think a lot of changes *can* take place and *will* take place but of course not everything can be done at once. It will take some time to reach those working in government, the people asking for the projects and the dredging industry looking towards these projects to be implemented everywhere. There are already some very nice examples and I think there will be a kind of snowball effect once people see that some of these projects were very successful. Then it will be very easy to multiply them and apply them in other sites as well.

Do you think the dredging industry can have a larger role in reversing environmental damage?

Yes for sure. There are different things. First of all our knowledge on how the system is functioning and the interaction between morphology, hydrodynamics, and ecology is increasing very fast. This is a crucial point that the dredging industry can take up, using this knowledge to change or adapt their programmes or projects in such a way to improve some of the functioning. Dredging in a classical way, by taking some sediment here and placing it somewhere else without taking into account the functioning of the system, will

Using an Ecosystems Approach

At the turn of the millennium, the concept of Ecosystems Services (ES) had been widely accepted among scientists for decades but was still entering the public conversation, going mainstream with the Millenium Ecosystem Assessment in 2005. In 2000, Patrick Meire published a report about the concept's application in the Scheldt estuary, and by 2016, co-wrote IADC's report *Ecosystems Services: Towards Integrated Marine Infrastructure Project Assessment* which oriented the ES concept towards the dredging industry.

In November 2018, at the CEDA-IADC Dredging for Sustainable Infrastructure Conference held in Amsterdam, he presented 'Using an Ecosystems Approach', one of four key enablers discussed in the book *Dredging for Sustainable Infrastructure*, CEDA and IADC's recently launched guidebook which elevates sustainable dredging to the next level. Following his presentation, the entire audience participated in a group, interactive activity which invited attendees to apply their newly acquired knowledge to mock project scenarios, making informed decisions with an ecosystems approach.

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no longer be accepted by the broader public and environmental NGOs. In addition, the cost of that is very high. Changing projects in a way which is more sustainable and enhance societal benefit and the environment will be, in my opinion, the future. The dredging industry can contribute to that by having new projects which improve or restore some of the damage to our systems that have been made before.

Do you think the damage done to rivers can be reversed or is it too late to make a difference?

It depends very much and this is very much related to climate change. If we do not keep global warming below 1.5 degrees Celsius, then the problems that will face our estuaries and deltas will become so big that we will not be able to resolve the problems we created in the past. The problems of the past will become bigger and bigger and bigger. I think if we are able to keep within these 1.5 degrees, then at least only part of the problems created in the past will be able to be solved. That will take a huge paradigm shift in the broader community, not only in the dredging industry but beyond it, to understand that we have to work *with* nature rather than *against* nature. Just think, in many of the deltas, the supply of sediments is limiting the accretion of the delta to grow with the sea level. These are all major problems that can be solved partly. And we will have to *really* understand the problems and tackle them, and then we will be able to partly solve it.

The Port of Rotterdam announced its Incentive Scheme Climate-friendly Shipping' to promote projects to attain zero-carbon fuels for ships passing through its port. What are your thoughts about the impacts of initiatives like this?

All of these projects such as incentives to emit less are very important. The Port of Antwerp is now working on a programme that when the ships are boarded, they use onshore power so that they do not have to generate it by themselves which means less emissions from their engines. There are many, many things that can be done and the more that organisations like the ports give incentives to do that, the more we can realise. In fact, its these big players who can make a *real* changes because if they require things from their customers or they put up some regulations, then it will have a much broader impact than just at the Port of Antwerp or Rotterdam. It will have an impact worldwide. They can play a crucial role in pushing sustainability a step ahead.

What your thoughts are about the plastic problem plaguing the world's waterways? Can initiatives such as Boyan Slat's The Ocean Cleanup help in tackling this problem?

The fact that Boyan Slat was able to put the macro-plastics issue on the agenda is the great thing that he did and is very important. At such a young age, to collect that amount of money to start something is really incredible. Until now, the most important point is that he put the issue of plastics – which is a crucial issue – clearly on the political agenda and that's a very big thing he did. If his strategy will work is a question to be answered, as we know the plastic is much deeper in the water and will thus escape from his construction. In my lab, we have a PhD student which is supported by several organisations studying the flux of macro-plastics in the Scheldt estuary and this work should be the basis for remediation of the problem. The crucial point is: how much plastic is being transported throughout the estuaries? That's just basic knowledge we need to have. Then, from where is the plastic coming? What is the major source of plastic towards the estuary? How is it transported in the estuary? We clearly see that in the upper layers of the water, a tiny fraction of what is passing through the estuary is found. It is at much deeper layers that the plastic is transported. There are big differences between the left and the right banks according to currents and so forth. We are trying to understand *where* the plastic is transported and then this knowledge can be used to design some measures that capture the plastics in a more efficient way.

Of course, this is just the end of the pipe solution. The *only* solution is that we prevent the plastic from *entering* the system. That is the end point. We all know that by now there is a lot of plastic coming into the system and cleaning it up before it is getting to the ocean will remain an important task for the next five to ten years or longer until we prevent any significant transport of plastic towards the rivers and the sea. So that is what we are doing. We are not working on micro-plastics or big plastics becoming micro-plastics as they are broken down in the water of course, but by removing the macro-plastics, the formation of micro-plastics can be prevented.

In addition to the plastic pervading the Scheldt estuary, is turbidity also a problem?

There are many problems. We are studying some ecological aspects and some issues on water quality in detail, and indeed also turbidity. Turbidity is a very crucial parameter in all estuaries because when there is a very high turbidity, then there is low primary production. Primary production – the production of organic matter by algae –needs light. If the turbidity is very high, then you have very little light in the water column. And therefore very little primary production.

In the Ems estuary, the turbidity increased dramatically over time, most likely due to deepening of the fairway. So in all of the estuaries, a lot of attention is given to the development of turbidity or suspended solids in the water column as it can be impacted by human activities and has a detrimental impact on the environment, at least in some circumstances. That's the reason we are following it carefully in the Scheldt. In the past years, there is indeed a slight increase in turbidity and the main question we are looking at is 'what could be the cause of this increase in turbidity?'. It is a very complex matter and right now, I cannot give any clue to the cause, but that is what we are looking at.

It can be due to anthropogenic reasons and it can also be due to natural phenomena which may be interacting or interfering with human activities. Though I cannot say yet, it is certainly something we need to follow up in detail and to look clearly to see how it is further developing.

Is the turbidity concentrated in certain areas or a ubiquitous problem?

Turbidity is indeed an ubiquitous problem. Many estuaries, such as Gironde, Humber, Ems and many others are very turbid and worldwide increased erosion causes increased turbidity in many rivers and coastal areas with often detrimental impacts on ecosystems, just think about coral reefs! But still there is a lack of knowledge. The turbidity is everywhere in the estuary and the problem with turbidity is that it is *extremely* variable. It varies during one tide. It varies over the seasons. It varies over the years because of differences in fresh water discharge due to a wetter season or a dryer season and so on. So it is very variable and is

occurring across the whole of the estuary. Now we see some patterns in the upper part of the estuary. There is an increase – although much less in the lower part than the upper part – but the explanation of the pattern is still pending and we are working hard to find out why.

We hope to have a clear hypothesis within one year but we must be honest and realise that turbidity and suspended sediments is such a complex matter. Many people are working to understand turbidity everywhere in the world. Within one year, we will certainly have some hypothesis and some more clear thinking about how turbidity is working in the Scheldt estuary, but because these are really complex systems, we will need many more years for everyone to really understand what is happening. The more we *know*, the more we know what we *don't* understand.

Can you explain why is there a sluice named after you in Kruibeke, Belgium?

The polders of Kruibeke cover an area between 600 and 700 hectares, making it the biggest flood control area in the Sigmaplan, the plan to protect the Scheldt valley against storm floods from the North Sea. The Sigmaplan is the continuation of the Dutch Deltaplan along the Westerschelde towards the Flemish part of the estuary. In the original Sigmaplan designed in 1976, this area was already indicated to be a very important flood control area, but the local mayor opposed it for many, many years. Starting somewhere in the 90s when I started to work on the Sigmaplan, we developed some of the ideas and concepts to develop this flood control area not *only* as a flood control area but partly as an area which is subjected to the tides and has an added ecological value. We worked very closely together with the public works department in designing the new concept. The polders of Kruibeke are now a combination of flood control and ecological development which is very beneficial for the estuary itself and has a very big added value for the community all around the area.

There are two big sluices on the site, one inlet sluice where the tide is coming in and one outlet where the water is going back to the estuary. I was honoured by the fact that the inlet lock is called the 'Meiresluis'. The outlet lock is the 'Meyvissluis', named for Meyvis, the engineer of the public works department with whom I had been cooperating very closely to realise the project. Together, we were able to change the original idea and concept, and also to get a lot of the people behind us and the new concept. The local people now very much enjoy the area for recreation, in fact there are a lot more people enjoying the areanow than before. In addition, it provides many ecological values and ecosystem services, and on top of that its crucially important for safety.

It was an honour for all the work we have been doing there and realising this project finally notwithstanding that the local mayor had been opposing it for twenty to twenty five years. There was opposition from the local government and we were able to gradually counteract that. The Flemish government finally decided to go ahead with the plans we had been making. The whole project was inaugurated in June 2017.

How did your research on the glaciers in Greenland come about and can you offer some insight of your observations there?

That's a different story. My son went to Greenland more than six years ago for his PhD. He stayed there for a long time and did his work on the impact of the melting glaciers on the biogeochemistry of the fjords. Some of the measurements that he was doing in Greenland are similar to the measurements that we are doing in the Scheldt estuary, so we worked together on that. Some of the samples he took there are being analysed in my lab and we already published a few papers together. For the last two years, in 2017 and 2018, we went on a cruise in Greenland for sampling together which was very nice to be able to join and work with my son in a very exciting environment. So that's in fact my experience there. My oldest son is working at Flanders Hydraulics also on the Scheldt estuary and it is really a great thing for me to be able to work together with my children on such exciting topics and to see the next generation taking up the job!

But let's go back to Greenland. The main issue is to try to understand how the melting of the glaciers is impacting the fjords because the fjords' systems are in fact marine systems. Due to the increased melting of the ice cap and the glaciers, the amount of fresh water coming into the fjords is *increasing dramatically* and the *way* the fresh water is coming into the fjords is *changing*. Whether you have a calving glacier or a land-terminating glacier has a big impact on *how* the water is coming into the estuary and into the fjords.

We are looking at how this is affecting the productivity and the whole biogeochemistry of the fjords. This is very much related to the melting because in former times most of the glaciers were typically calving glaciers – when big glaciers lose the ice directly into the fjord – and certainly by melting the glaciers retreat. At a certain moment, the glaciers come on land and then in fact the ice is not falling in the fjord anymore but you have a small river which is moving towards the fjord. When you are there in the region, you can clearly see the rocks where the glaciers have been just a few years ago. From the local people, you hear 'at this place there was a calving glacier ten years ago' and now hundreds of metres or even kilometres away, you see the edge of the glacier on land. So that is really confronting. There, you feel the climate change happening and the ice melting. If you are sailing there and you see this huge amount of fresh water discharge towards the sea and you see how incredibly huge the ice cap is, then you start to realise sea level rise is an issue and we will have to be extremely careful for that.

That's also the reason this threshold of '1.5 degrees' is so important. If we get a sea level rise of four, five or six metres, then I'm afraid it is the end for the Netherlands, Flanders and for many other areas as well. Having and coping with a sea level rise of several metres will be completely impossible. Just imagine Amsterdam, Rotterdam, Antwerp and Bruges: all of these cities will become flooded within one hundred or one hundred and fifty years. To just imagine that all of these huge monuments are flooded by the sea because there is a five to six metre sea level rise, that idea is unacceptable. That is the reason we must really act.

Have your measurements from Greenland contributed to your realisation or would you say that 'seeing is believing'?

Its double. By studying it, you start to understand the mechanisms, but its sometimes difficult to understand the magnitude from behind your desk or computer. If you were in front of such a glacier or fly over the ice cap, you see the size of it. By seeing the magnitude, then this gives you a better understanding of the potential consequences. And it is a difference if you see that compared to just seeing it as

graphs on your computer screen. Yes you see the regression, the glaciers have retreated ten kilometres in the last ten years, but if then you see what an immense amount of ice and water this means, it gives you another dimension. So it is the combination which makes me understand what it is and what is the importance. Just being there and seeing the glacier without understanding the background is still not enough. Having the combination of both is really impressive and important for me.

An aerial view of the Meiresluis – the sluice named after Patrick Meire in Kruibeke, Belgium – at its inauguration on 24 June 2017.

Is there a way to convey your first-hand experience to those that don't believe in climate change?

That is a very good question. I wish I had a very good answer to that. Professor Jean-Pascal van Ypersele who is the most well-known climate scientist from Belgium, and was also vice chair on the intergovernmental panel on climate change, has given hundreds of lectures about climate change and went into hundreds of debates, He mentioned 'I don't want to debate with non-believers anymore because you will not get any advance with that'. They very often say ' I don't believe it' or state things without any background. Just discussing with these people will not help.

What is very important is to give the right information as a scientist. Luckily, a growing part of the population is indeed listening to this message and starting to understand that we need to do something. It is the biggest issue that humanity has ever been confronted with because all the previous environmental issues were all local. There would be pollution in one river and smoke in several cities but it was still localised. Climate change is really global. Everybody, everywhere – in every square metre of the globe – is impacted by climate change and that makes it such an immense challenge for humanity to tackle that. More and more people are starting to understand it. It's with those that we will have to continue forward and to see it as a challenge. Climate change is a huge problem and either we can say 'it's too big a problem and we cannot solve it' but this means the next generation will suffer. Or we can say 'we have a problem but let's tackle it' and let's look to the ways to get out of this problem. For me, the second way is the *only* way we can go forward and that can only create a better society.

Resumé

1999-Present
Full Professor in the Department of Biology at University of Antwerp

2013-2018
Chair of the Department of Biology at University of Antwerp

1999-Present
Head of the Ecosystem Management Research Group (ECOBE)

2008-2014
Chairman of IMK/IMDO (Institute for Environment and Sustainable Development)

2004-2008
Academic Secretary of IMK/IMDO

1995-1999
Guest Professor of IMK/IMDO

www.uantwerpen.be

2012-Present
Visiting Professor at Warsaw University of Life Sciences

www.sggw.pl

1990-1999
Senior Scientist at IN/INBO (Research Institute for Nature and Forest)

www.inbo.be

1989-1990
Senior Researcher at Netherlands Institute of Ecology (NIOO-KNAW)

https://nioo.knaw.nl

1986-1993
PhD Candidate at University of Ghent

1980-1990
Research Assistant at the Laboratory of Animal Ecology, Zoogeography and Nature Conservation at University of Ghent

www.ugent.be