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Gustaf Olsson is a water science and system thinking super hero

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It is with a great sense of external gratitude, humility, admiration, and solidarity that I write this tribute to honour Emeritus Prof. Gustaf Olsson, a borderless mentor of smart water science and an advocate of system thinking (water–energy–economy–climate–lifestyle nexus) for sustainability. I presume that my piece is a lone contribution from the Niger Delta, Nigeria, a region where Gustaf has written copiously about the human rights consequences of unprecedented degradation of the total environment and poor management by the oil industry. Thus, I elect or volunteer to convey the united thanks of the peoples of the Niger Delta, on whose behalf Gustaf has passionately exposed the sufferings caused principally by poorly regulated oil spills and their avalanche impacts on water, food resources, and livelihoods. His consistent advocacy for immediate, sustainable cleanup, remediation, and restoration of the extensive oil-degraded ecosystems in the Niger Delta has started to yield tangible results.

My background is in zoology, with a focus on hydrobiology, specifically benthic and restoration ecology. On the contrary, Gustaf is an emeritus professor of automation engineering. These specialties are far apart, but we have been bonded by the common water trait of our studies. His towering posture, contributions, and mentorship in the water–energy nexus are outstanding and have had great influence on water management, and will continue to impact on current and future water sustainability designs, policies, and practices.

As part of my doctorate, I researched community ecology of intertidal macrozoobenthos (animals >0.5 mm that live in or on sediment) of the Bodo Creek, collecting field samples for two years (May 2006–April 2008). Four months after the end of my sampling campaign (August 2008), Bodo Creek was hit by two major oil spills. Thus, the data I had collected became useful pre-spill baseline with which the Bodo oil spill impact was assessed and the data continue to serve as valuable reference for monitoring water quality recovery in the creek.

Given poor oil spill management regime in Nigeria, the 2008 Bodo Creek oil spill was almost swept under the carpet – despite the heavy impact on livelihoods of the local population. I took the initiative of documenting the post-spill conditions and talked about the spill's human rights consequences in many international fora. I eventually introduced the spills to Leigh Day & Co law firm in the United Kingdom for prosecution. The case was formally filed in a London court in April 2011. The welter of evidence forced the liable company, the oil giant, Shell, to settle out of court in 2015. Consequently, 15,601 claimants who suffered losses and the Bodo community were compensated with 55 million pounds. Given the long walk to justice, Gustaf wrote a compelling letter in support of my nomination that led my being the recipient of the Association for the Sciences of Limnology and Oceanography (ASLO) 2022 Ruth Patrick Award.

On April 27th, 2009, I was invited as a guest speaker at the conference 'Petroleum and Pollution – How Does That Impact Human Rights?', co-organized by Amnesty International, Forum Syd, and Friends of the Earth, Sweden, which was held at Kulturhuset, Stockholm, Sweden. In my lecture paper titled 'Impact of oil pollution on livelihood in Nigeria', I highlighted the impact of the Bodo Creek oil spill on water quality. A few months after the conference, Anna Gustafson, one of the conference organizers, emailed to introduce Prof. Olsson to me. This was how our paths intersected and I got to know and continue to learn from this great teacher and advocate of smart water use.

In his seminal book that ensued, 'Water and Energy – Threats and Opportunities', published in its first edition in 2012, Prof. Olsson amplified access to water as a fundamental human right and highlighted the consequences of a lack of access to sustainable, safe water, using the Bodo Creek spill as a case in point. He uses the textbook to plead for cleanup, remediation, and restoration of the creek. In 2015, he published a significantly upgraded second edition of the book. This coincided with the above out-of-court settlement and payment of 55 million pounds as compensation to the impacted people in the Bodo communities. Prof. Olsson discussed the relief and sense of justice achieved by the compensation and, again, reminded water professionals of the urgent need to clean up the degraded waterways. Clean up (free phase oil removal) of the Bodo Creek started in September 2017. The remediation and restoration of mangroves that followed the initial phase is ongoing for over two years now. The anticipated planting of 1000 ha of mangroves in the Bodo Creek would make it the world's largest restoration of oil-degraded mangrove. These have created direct jobs for about 2500 locals.

Prof. Olsson has had an uncommon and outstanding impact on the advancement of water science and water-wise technological development. He flags the problems and challenges, exposes the drivers of the challenges, and proposes smart and innovative solutions to fix the problems. He is a mentor par excellence. He introduced me to the International Water Association (IWA), a gesture that has helped to push back the frontiers of my water career. I have had the privilege and honour of co-authoring two conference posters and a refereed journal article with him (Olsson & Zabbey, 2012, 2014; Zabbey & Olsson, 2017).

Our latest submission 'Water science and human rights: a case study from the Niger Delta' has been accepted as a poster presentation at the September 2022 International Water Association (IWA) World Congress in Copenhagen.

I'm eternally grateful to Gustaf for the superb lessons and skills I and countless other mentees garnered from his mentorship. In the Niger Delta, as in similar developing lands, we conduct field research in very challenging circumstances – poor funding, limited state-of-the-art sampling and analytical equipment, and insecurity due to armed militancy, kidnapping, and demands for 'matching ground', a kind of bizarre, illegal entry permit levy that some local youths collect. The below personal experience I had and have shared with Gustaf graphically illustrates the risks that researchers in conflict-prone regions are exposed to.

> I was offered the 2016 British Ecological Society (BES) Ecologist in Africa grant to study Polychaete diversity in varied health-integrity habitats in different reaches of the Bonny Estuary, Niger Delta. The study involved collecting polychaeta samples from oil-degraded and relatively undegraded areas in the upper, middle, and lower reaches of the Bonny Estuary, and identifying the specimens under expert supervision at the Los Angeles Museum of Natural History, USA. While collecting the polychaete samples with some of my students in 2018 at the middle reaches of the Bonny Estuary, we were once intercepted by an armed gang. The boys had three AK-47s in their speedboat. They seized our Eckman grab, water quality multi meter, and some of the benthic samples we had collected and towed our boat ashore to the Seato fishing camp where they were residing then. We begged them to free us and they insisted we should've obtained permission from them before coming to collect samples. I responded that we are only trying to preserve the environmental legacy of the region and that I am a native of Bodo City (the community that owns the Seato fishing camp), but to no avail. The incident occurred in the waters contiguous to Seato, the mouth of one of the four main channels that connect the Bodo Creek complex to the Bonny River. Luckily, our boat driver phoned another gang leader who talked to our captors, and we were released with a stern warning. After the grisly incident, I've been brooding over how we can collect environmental data in the Niger Delta in conjunction with non-science citizens or build the latter's capacity to collect useful data from remote insecure areas. Thus, with a few colleagues, we developed a framework for the region's community science. On August 4th, 2020, we tested the community science framework with several undergraduate volunteers and youths from the Bundu Waterfront neighborhood to document mangrove biodiversity in the Bundu Creek, Port Harcourt. Interestingly, I met in Bundu one of the boys that had held my students and I hostage for a few hours in 2018 on the Bonny River. He has expressed regret and informed me that, of his gang, he is the sole survivor. He claimed that a rival cult group attacked the place where they brought us and massacred all of his gang members while he managed to escape. He is a

potential citizen scientist! He is currently collaborating with my team at the Center for Environment, Human Rights, and Development (CEHRD) on a modest Global Green Grant-funded project in Bundu for sustainable waste management and mangrove restoration.

In sum, great efforts and sometimes risks to personal safety go into collecting sound temporal field data in the Niger Delta, especially in the wilderness or remote mangrove areas. Thus, until I started to co-author with Gustaf, I usually got upset and seemingly frustrated when I received uncomplimentary peer-review feedback on my manuscripts that contained 'hard-acquired' datasets. As the correspondent author, in fact, the *de facto* lead author of our joint paper above 'Conflicts – oil exploration and water', Gustaf taught me a life-long lesson in the virtues of scholarly patience, humility, and tolerance. I was amazed by the incredible calmness and humility with which Gustaf responded to what, in my estimation, were rude review remarks. This changed the way I perceived reviewers' comments. It makes me appreciate the importance of blind peer review even more. It's more likely that the reviewers of our paper are his juniors or mentees. Had they known the manuscript was Gustaf's, their review comments would have been less critical, but kinder all-round commendations that wouldn't have added value to the paper!

Prof. Olsson's 2016 classic book, 'Smart Water Utilities', which he co-authored with his former PhD student, Pernille Ingilsen, will continue to influence water professionals' and policymakers' water-wise innovative thinking, system design, judgment, and practice for a long time. As a trusting mentor, Gustaf is, he gave me the rare privilege of contributing a case study in the book titled 'The Risk of NOT Measuring—Oil Exploration in the Niger Delta' in the book; pp. 227–230. The book chapter analyses state-of-the-art technologies for surveillance and monitoring of oil facilities for early warning signals and detection of oil spills for prompt contingency response. It also highlights the long-term benefit of investing in the seemingly expensive technologies as being superior to the cost of catastrophic oil spills due to poor or inadequate pipeline monitoring, maintenance, and leak-detection regimes in regions with poor oil spill management such as the Niger Delta.

Gustaf had shared with me the draft of his latest book (in press) 'Water Interactions – A System View', in which he expounds the intricate connectivity between water–climate–energy–food–economics–lifestyle. This was quite providential. A couple of days afterwards (in April 2022), the revered Niger Delta environmental rights activist, Rev. Nnimmo Bassey, asked me to write a review paper on the relationship between climate change, environmental degradation, insecurity, and conflict in the Gulf of Guinea, using the Niger Delta as a case study. I'm not yet very familiar with the terrain of climate change science, but Gustaf's new book, the insights and suggestions he shared with me via email, and the literature he provided bolstered my confidence to write the paper, and I delivered it on time. With the enormous time commitment Gustaf dedicates to younger professionals like me and the speed with which he responds to our ongoing requests for his scholarly thoughts and guidance to navigate contemporary water science issues, I frequently wonder if he operates on a

daytime length longer than 24 hours! With his proactive literature provisioning and personal insights, I'm extremely glad I wrote the paper because it evokes in me a sense of guilt that I'd paid little attention to the impacts of climate change on my region. The Niger Delta, according to the research, is one of the regions that has felt the impact of climate change, particularly coastal flooding and erosion. It demonstrates to me how the double whammy of environmental degradation and climate change weakens resilience, adaptation, and mitigation capacity and exacerbates insecurity and conflict in the region. When I delivered the paper to Rev. Bassey, who commissioned me to write it, I shared it the same day with Gustaf, the unseen towering personality behind the article.

Prof. Gustaf Olsson's career has contributed remarkably to the body of knowledge on water systems engineering, the connection between water and energy, innovative water-wise technologies, and the human rights impact of poor water quality. He continues to evolve and communicate system-thinking solutions. His work has had a huge impact on the water science community, as well as water managers and policymakers. In 2018, I was extremely delighted to have written one of the letters in support of his nomination for the Stockholm Water Prize. Honestly, by my estimation and that of countless colleagues across the world, Gustaf would be a worthy recipient of the Stockholm Water Prize! I hope his priceless contributions to water science system thinking will be duly rewarded in the near future. Whether he wins the Stockholm Water Prize or not, he is the hero of heroes of water science! His contributions will continue to inspire us.

Gustaf Olsson and Nenibarini Zabbey before the presentation on "Rehabilitation of mangroves degraded by oil spills in the Niger Delta" at the World Maritime University, Malmo, Sweden, in July 2022.

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