

## Obituary: Professor Duncan Mara (1945–2022)

Professor Duncan Mara DSc(Eng), CEng, CBiol, FICE, FIB, FCIWEM, FRIPH, FHEA, who has died at the age of 77, was a world-leading researcher and academic in the field of public health engineering. His contributions to the development of sanitation changed global thinking and had a profound effect on the lives of millions of people.

During an academic career that spanned more than fifty years, Professor Mara dedicated his life to seeking out effective ways of reducing the risks of infectious faeco-oral disease transmission. After studying civil engineering at undergraduate level at St Andrew's and for his PhD in Dundee he rapidly identified his niche as a researcher and scholar. From his first academic post, at the University of Nairobi, Kenya in 1970, to his appointment as visiting Professor of Sanitary and Environmental Engineering at the Universidad del Valle in Cali, Columbia in 1996 he was committed to the development of an effective international research community who could tackle the enormous challenges associated with historic under investment in sanitation services. After serving in Nairobi for three years, Dr Mara took up a Lectureship in Public Health Engineering at the University of Dundee in 1973. Promoted rapidly to a senior lectureship he was shortly after snapped up and appointed in 1979 one of the youngest ever Professors at the University of Leeds, a post he held, eventually as Emeritus Professor of Civil Engineering, until his death.

It is impossible to imagine now the enormity of the challenges faced by the world in terms of faeco-oral disease transmission in the early 1970s. While huge numbers of people lacked access to even a basic toilet, and as the urbanisation explosion of the late twentieth century was already ramping up, sanitation solutions were limited to wastewater based technologies which were already nearly a century old, were slow to be rolled out and were failing to keep up with the changing global reality. The international aid architecture was dominated by conventional engineers whose technical knowledge was limited to sewer systems such as those which had been built 100 years before in the UK and Europe. The young Dr Mara was convinced that there were better ways to tackle the real life crisis he could see on the streets of Nairobi. He set about trying to find some of those urgently-needed solutions.

His relentless focus, drive and determination have ensured that the results of his research continue to translate into real changes and improvements to both morbidity and mortality of the extreme poor in low and middle-income countries. He led the development of novel low-cost wastewater treatment approaches for hot climates, including ground-breaking research on waste stabilization ponds (WSPs), initially in Kenya (1970–73) and then in Brazil (1976–1985), and Colombia (1985–2012). This was further applied to the use of WSP for small communities in the UK and Europe, including the wholly innovative development of aerated rock filters (which are now in use in Australia and the US).

Before Professor Mara's exhaustive research on waste stabilization ponds, design methods were varied and unreliable. Little was known about the precise mechanisms of operation and how they achieved the high levels of treatment for both organic matter and pathogen removal. Many systems were either over-designed (thereby wasting land) or under-designed (thereby causing operational problems). Through a systematic evaluation of performance, the research teams he led provided the basis for greatly improved design procedures for both the process and the physical design of WSPs. This resulted in an increased uptake of the technology in both low- and high-income settings. As the knowledge improved, various hybrid designs were developed, for example, high-rate anaerobic ponds, which offer the dual advantages of a simple and cheap construction with the benefits of up-flow anaerobic sludge blanket processes. Complementary innovations that he developed included the addition of rock filters and other systems to improve WSP effluent quality and design protocols for effluent storage reservoirs. Today Mara's work is considered *the* design standard by which others are measured. He has produced design manuals, including operational experience, for many different regions of the world.

He also carried out revolutionary research and development on low-cost sanitation systems principally for poor urban/rural settlements in developing countries and was an active member of the World Bank/UNDP Technology Advisory Group in the 1980s. This work has led to the development of design procedures for, and subsequent global adoption of,

ventilated improved pit latrines, pour-flush toilets, and condominal sewerage – in the case of the latter approach to providing sanitation services for the ubiquitous informal, unplanned, densely-populated low-income areas of developing country cities, Duncan worked with the ‘condominal gurus’ from its inception in Brazil in the early 1980s in order to systematise its design approach and disseminate its benefits around the world.

He continued to push for improvements and was working on new approaches to sanitation in humanitarian crises at his death.

Alongside his research, at Leeds Professor Mara had a profound impact on the teaching of civil engineering. Multiple generations of engineers were captivated by his lectures on International Public Health, with countless careers being launched from the cramped seats of Lecture Theatre A in the Civil Engineering building at the University of Leeds. Undergraduates were soon joined by post graduates who undertook the highly innovative Masters in Tropical Public Health Engineering (TPHE) as it was initially called. This course, now with a new identity of Water, Sanitation and Health Engineering, continues to this day; its graduates represent one of Duncan’s lasting legacies. His teaching style was direct, as matched his enormous intellect, and many students found to their astonishment that it was near impossible to match the level of reading, analysis and thinking required in Duncan’s classes. But as he made the topic so compelling and conveyed the urgency with such vigour, few flagged and almost all made the efforts required to achieve the standards demanded by Professor Mara.

A select few also had the opportunity to study with him at PhD level. The small dedicated cohort of researchers that moved through the School in the 1980s and 1990s in particular produced a notable crop of important research results. This cohort has also gone on to lead the sector in many ways. Alumni from Professor Mara’s classes can be found throughout the world, occupying University Chairs, and senior positions in organisations as diverse as the World Bank, the Bill and Melinda Gates Foundation, Engineering consultancy firms, local and national government and non-governmental organisations.

Throughout his career Professor Mara collaborated with a huge range of partners in government, in international agencies, and in academia around the world. One of his lasting contributions is in the field of managing the risks associated with use of wastewater for irrigation. During the 1980s and 1990s he led a range of research projects which helped to establish the mechanisms by which use of contaminated wastewater on food crops can contribute to increased risks of infection in people consuming those crops. In collaboration with others, Professor Mara was able to use his growing understanding, together with new modelling tools, to help establish new guidelines for safe reuse of wastewater. This work was later enshrined in the 2006 Guidelines on Reuse of Wastewater issued by the World Health Organization. He continued to lobby for improved application of the principles that this work established right up until the end of his career, and continued to produce new analysis to help shed light on this challenging topic.

Duncan’s life, and particularly his early upbringing, were overshadowed by the death of his father Flight Lieutenant Neil Duncan Mara of 433 (Porcupine) Squadron, Royal Canadian Air Force, who died on operations in February 1945 and who was posthumously awarded the Distinguished Flying Cross (DFC). Growing up with his mother he was a highly academically gifted child, who carried his broad learning lightly throughout his life. He went to Downside, a very prestigious catholic college, where he excelled in the classics. He always said that he gained his first experience of research from a Latin teacher, who tasked him with finding the meaning of a particular text. Naturally he took Latin, Greek and Ancient History at ‘A’ level and, with a place secured at Oxford, was destined for the life of a classics scholar. However a chance encounter while working on a building site turned him from classics to engineering. As it wasn’t possible to get into an engineering degree with the three ‘A’ levels he already had, he eschewed Oxford for Bath Technical College, took all the requisite A levels (maths, physics and chemistry) in a year, and so got to St Andrews to study for his undergraduate degree in Civil Engineering. He went on to study for his PhD on Sulphate Reducing Bacteria and Corrosion. Never one to take his foot off the accelerator, he wrote and published his first book ‘Bacteriology for Sanitary Engineers’ when he was 29.

His early classics training stood him in good stead, and his natural aptitude for languages remained, as he took pains to learn the languages of all the countries in which he worked, spoke excellent Swahili in Nairobi, and to the end of his life gave lectures and wrote books in fluent Portuguese.

Firmly established as a polymathic engineer, with the option to take any number of directions it is fortunate that his fascination with public health and the opportunity to live and work in Nairobi were to have a lasting influence on his career. This choice is one for which many people can be grateful. Professor Mara’s work has had an immense impact, and his contributions will remain widely recognised, his more than 30 books and 250 scholarly papers widely read and his ideas deeply influential for many years to come.

His legacy is immense, and the impact of his work is profound. His driving engineering values were centred on simplicity and compassion. He will be sorely missed by innumerable colleagues and friends around the world. It is perhaps not surprising given his background that Duncan was deeply attached to his family, and is survived by his much-loved wife Margaret, children Jackie and Neil and four adored grandchildren. The epitaph on his father's grave in Belgium stands for them both, and simply states:

OUT OF THE STRESS OF THE DOING, INTO THE PEACE OF THE DONE. REQUIESCAT IN PACE

Leeds

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