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Water Matters

An insight into the successes and challenges facing the European water sector

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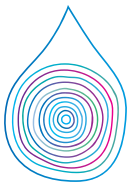
The European Federation of National Water Services



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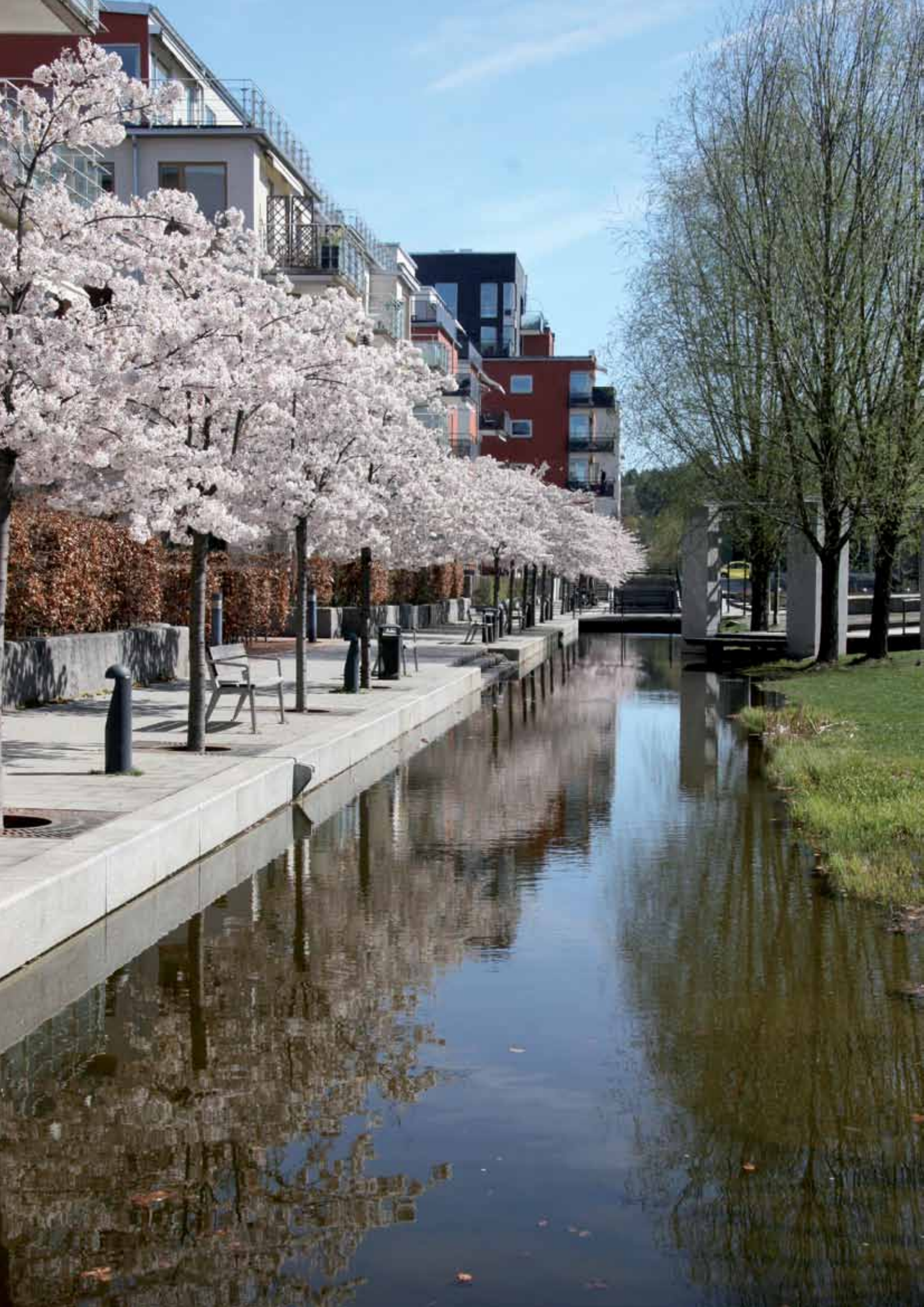

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The Stockholm eco-district Hammarby Sjöstad has water central to its soul, developed around Hammarby Lake and with its own storm water management system. **Credit:** Catherina Eriksen

Cities of the future

Zero sludge production may seem the impossible dream of municipalities, yet considerable sludge reduction can be achieved with bio-augmentation

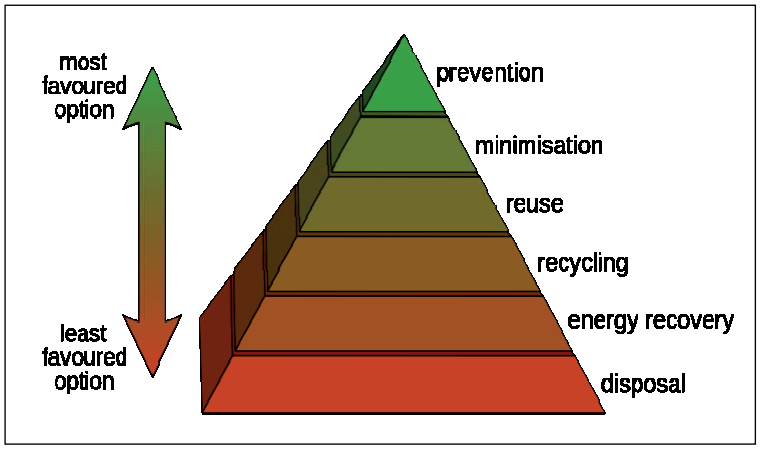
By Mark Sklivaniotis and Andreas Angelakis, Honorary Consultants at the Hellenic Association of Drinking Water and Waste Water Municipal Companies

The management of bio-solids (sludge) derived from the treatment of domestic waste water has been a difficult issue for years. A great deal of research and technological innovation have evolved around this problem. This material is a solid waste which, if not managed properly, generates difficulties in two critical infrastructure sectors: waste water treatment and solid waste management. The general approach of solid waste management is usually portrayed by a pyramid (*Figure 1*):

In a report prepared by Milieu, WRc and Risk & Policy Analysts for the European Commission, the estimated sludge production for 2010 was 11.6 million total dry solids tonnes per annum (TDS) with the following disposal distribution: recycled to land 42%; incinerated 27%; landfill 14%; other 16%. For Greece, it was 260.000 TDS: recycled to land 5%; incinerated 0%; landfill 95%; other 0%.

In Europe, the main management options are in the three lower parts of the pyramid, whereas in Greece, the lowest level of the pyramid is the predominant choice. This has shortcomings. First, the addition of sludge to municipal solid waste creates a lot of handling problems and has forced many municipal landfill operators to request significant sludge input minimisation or to sharply increase the gate fee. Secondly, there is the EU policy to minimise the organic part of the waste deposited to landfills to less than 5%. In the long run, this practically bans sludge from landfill sites.

Figure 1.



In Patras, with a population of 220.000, the sludge management problem from waste water treatment plants endangered the smooth operation of the plant. After outsourcing sludge transport and disposal services to far away composting sites, various options were examined for a viable, environmentally friendly and cost-effective solution. Besides the practical and financial aspects of the alternatives, social mistrust and opposition for any activity involving sludge management was strong. So 'climbing to the top of the pyramid', and, therefore, a zero-sludge process, became necessary.

A number of private companies' case studies claimed considerable sludge reduction using specific and dedicated micro-organisms and micro-nutrients contained in their product. In some cases, this was claimed to be as high as 50%. This method is called bio-augmentation. Veria, with 70.000 inhabitants, applied bio-augmentation for some time and, most importantly, used Greek technology. They claimed to be able to get to the top of the pyramid, avoiding the production of sludge by more than 85%. A pilot application began in Patras in 2014, which extended to a permanent operation.

What is bio-augmentation?

Bio-augmentation enhances the process of the biological decomposition of pollutants in waste water by naturally occurring micro-organisms. This is done through adding selected micro-organisms that are far more efficient in converting the carbon and nitrogen compound to carbon dioxide and nitrogen without producing a lot of extra biomass population. These micro-organisms

are facultative, capable of functioning in aerobic, anoxic and anaerobic environments. The bacteria are not genetically engineered; they are naturally occurring but specially selected.

The added bacteria become dominant and the existing ones are adapted and assimilated to coexist and collaborate. In suitable conditions, the added micro-organisms produce enzymes that enhance the biological process. The degradation of complex molecules, oils and greases into simple ones leads to the production of volatile fatty acids (VFAs), i.e. acetic, butyric, propionic acid, etc. The VFAs are then easily converted to carbon dioxide and water in aerobic conditions, methane and hydrogen in anaerobic conditions and free available energy. The breakdown and molecular destruction occurs in up to 80% of the total biomass through catabolism. Only 20% of the total biomass is utilised for the synthesis of new bacteria. The process requires less oxygen supply as the ammonia is converted to nitrites and then nitrogen without first being converted to nitrates where the largest consumption of oxygen occurs, depending on operational conditions.

Adding sludge to municipal solid waste has led to problems with landfill operators, who have asked for sludge input minimisation. Furthermore, the EU has stipulated that sludge should be, at most, 5% of the landfill total.

Application cases in Greece

A number of successful cases are running in Patras, Veria, Heraklion and a few other cities, not to forget a few cases in the islands, like Corfu and Lesbos, where sludge management is a more difficult issue.

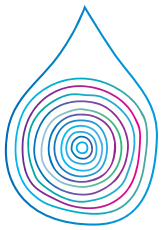
In every case, the benefit is not limited to sludge reduction. Some of the other benefits are: great odour reduction; robustness to load variations; resistance to toxic 'attacks' (NH4 180mg/l); small but measurable energy reduction; and the reduction of maintenance (limited dewatering). There are also financial gains. The cost of the technology application is a third of the cost for sludge management without counting the saving from lower electricity and chemical consumption as well as the man hours engaged in dewatering activities.

One extra note of environmental significance: the University of Patras measured the inlet and outlet concentrations for a number of pharmaceutical substances detected in sewage. Its data confirms that the removal efficiency was 85-100%, which is much higher when compared to a typical biological waste water treatment process. This is very encouraging but has to be confirmed with more case studies.

Is this the end of sludge?

This technology can only be seen as one more tool in the battle to manage the biological treatment process and could be of great help when sludge management problems are difficult to solve. Despite the fact that this particular Greek technology achieves near-zero sludge production, other bio-augmentation technologies report sludge reduction of almost 50%. So sludge will never go away. In cases where the general circumstances are right, sludge can be an energy source and an asset. Having said that, we must not exclude larger energy gains from the application of bio-augmentation. Since facultative bacteria that act most effectively in an anoxic environment are the main 'instrument' of the process, further study and optimisation of the process application can bring considerable reduction in aeration cost, which will probably outperform the energy gains from the potential biogas production if sludge was produced.

Some cities of the future may indeed work with near-zero sludge production in terms of waste water management. Bio-augmentation can be one tool in achieving this and certainly there are others. What is most important to remember is that innovation is the most powerful lever to development and success. Sometimes innovative ideas look crazy but they must be given a chance. And sometimes they come from a spot of the globe that is not a typical 'technology power'.



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