EMBO reports

opinion

Water

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One of our most crucial and finite resources is freshwater. How often do biologists spare a thought for this substance, other than to think about its purity for the sake of an experiment? How often do we consider that 30 litres of cooling water are used to make one litre of double-distilled water? Americans use approximately 100 gallons per person per day, whereas millions of the world's poor subsist on less than 5 gallons per day. Within the next 15 years, it is estimated that more than 1.8 billion people will be living in regions with severe water scarcity, partly as a result of climate change. By 2030 it is estimated that the annual global demand for water will increase from 4,500 billion m^3 to 6,900 billion m^3—approximately 40% more than the amount of freshwater available (Water Resources Group, 2009). We are not only facing an increasing scarcity of water, but we also misuse the available water. Approximately 2.5 billion people use rivers to dispose of waste—not to mention what industry dumps into them—while freshwater dams generate problems of their own including population displacement, the spread of new and more diseases to people living in the vicinity of the river, as well as effects on ecology and farming downstream.

Many factors influence the supply of and demand for water, and a one-fits-all solution for all regions is therefore not possible. There are essentially two strategies to ensure a sound supply of freshwater: we either use less water, or we make more of the water that we do use. The first is a typical accounting approach and is limited in scope, whereas the second calls for better science and engineering approaches.

Although the surface of the Earth is mostly covered with water, more than 95% of it is salty or inaccessible. One clear solution to increase fresh water supply is desalination, which can be done by distillation or osmosis, through the use of carbon nanotubes, or by using another promising new technology: biomimetics. Water can be filtered through aquaporins—proteins that transport water molecules in and out of cells. Such biotechnologies could reach the market as early as 2013, although other exciting technologies are already available. Simple chemistry can be used, for example, in the 'PUR' water purifier that uses gravity to precipitate water-born contaminants and pathogens or the water purifier akin to a trash bag, which cleanses water through a nanofibre filter containing microbicides and carbon to remove pollutants and pathogens. Such simple and cheap technology is ideal for billions of the world's poor who do not have access to clean drinking water.

Of the available freshwater, agriculture uses the largest share—up to 70% in many regions—and technological and biotechnological solutions can also contribute to preserving water in this context. New farming processes that can retain water in the soil, recycle it or reduce its use include no-till farming, crop intensification, improved fertilizer usage, crop development, waste water re-use and pre- and post-harvest food processing, among many others. The different degrees of water quality can also be exploited for agriculture; 'grey water'—which is unsafe for human consumption—could still be used in agriculture.

In addition to improving management practices, there is no question that we need considerably more innovation in water technology to close the supply–demand gap. These developments should include better processes for purification and desalination, more efficient industrial use and re-use and improved agricultural usage. The problem is that the water sector is poorly funded in all respects, including research. New technologies could help to re-use water and reclaim resources from wastewater while generating biogas from the waste. There is also enormous potential for the use of water beyond its consumption in households, agriculture and industry. 'Blue energy', for instance, generates power from reverse electrodialysis by mixing saltwater and freshwater across an ion exchange membrane stack. This could potentially generate energy wherever rivers flow into the sea.

With so many innovations already under way with so little funding, what other technologies can we come up with to reduce water usage and deal with medical, industrial and individual waste? The issue of waste is a serious and pressing problem: we find pharmaceutical chemicals in fish, which are in turn consumed by humans and other species in the food chain. We need to find ways to effectively transform waste into biodegradable products that can be used as fertilizers, as well as to recover valuable molecules such as rare metals. The downstream consequences of such technologies will be the regeneration of coastal estuaries, lower levels of contaminants in marine life and cleaner rivers. Ultimately, we need much more research into reducing water use, purification, bioremediation and recycling. I submit that this should be a priority research area for all the natural sciences and engineering.

Companies are held accountable these days for socially responsible projects, sustainability and their carbon footprint—this includes water usage. Why should research institutions not be held responsible too? After all, we claim to be at the cutting edge of science and should set the trend. Research grants should have a 'green component' and a score should be given to applications according to water usage and 'green work'.

REFERENCE

Water Resources Group (2009) *Charting our Water Future*. www.mckinsey.com/clientservice/Water/Charting_our_water_future.aspx

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