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Sustainable Water



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EDITORS: R.E. HESTER AND R.M. HARRISON

31

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Sustainable Water

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Foreword

In August 2009 the Royal Society of Chemistry (RSC) hosted the ‘International Union of Pure and Applied Chemists’ 42nd Congress in Glasgow. This congress featured over 50 symposia, which highlighted the positive impact of Chemistry on the world around us.

A key symposium within the congress focused on sustainable water and the impact of climate change, economics, social justice and changes in the population on water resources. This book showcases some of the topics of discussion that featured in the symposium and emphasises the importance of chemical sciences in achieving sustainable water resources on a global scale.

The RSC has considered how chemical sciences can support sustainable water resources in their Water Sustainability Report published in 2007. The report itself focuses on the key role of chemical sciences in supporting the future shape of water management and covers the entire hydrological cycle, paying particular attention to the management of domestic, industrial and agricultural water use, as well as contamination and climate change. The RSC has further developed water resource sustainability into its priority roadmap for chemical sciences. Both documents can be obtained through the RSC web site (www.rsc.org/ScienceAndTechnology/Policy/Documents/water.asp).

At a global level, pressure on water resources is increasing. There are many factors influencing the hydrological cycle and these include increased economic activity of developing and developed nations, urbanisation and increased population, together with human-induced climate change.

Every nation holds the right to advance its economic prosperity but this leads to greater abstraction of water and a higher risk of pollution, all of which has a profound effect on the environment and ecosystem health. Within the UK it is worth noting that Ecosystem Services, which is part of the government’s Department of the Environment, Food and Rural Affairs (Defra), has been set up to establish an ecosystem approach that is truly sustainable (see www.ecosystems-services.org.uk). This is aligned to the United Nations “Millennium Ecosystem Assessment” which highlighted the multiple benefits of an ecosystems approach to developing sustainable national policy. Ecosystem Services are developing research projects that will inform decision making at a national and local level within the UK and this all supports and contributes to sustaining water resources. It is clear then, that the key objective of the Ecosystem Services project is to make the link between ecosystem health, market forces and policy decisions.

Relating the ecosystem approach back to water sustainability can be done by considering the main drivers that influence the changes we face and understanding the common links and influences.

In the first instance we should consider environmental changes. This includes climate change, leading to temperature changes, precipitation changes and a build-up of greenhouse gases in the atmosphere. In addition to these factors we also observe that air quality in general is changing. All of these influences have an impact on the frequency of bad weather events, flood risk and drought. As an example, the increase in the temperature of the planet leads to an increase in snow and glacier melt which implies less winter storage of water that leads to a reduction of water availability in spring. Again, this has an impact on the sustainability of micro and macro flora and fauna within the ecosystem.

Climate change also has a profound influence on the ecosystem health, which puts natural resource availability at risk and limits a nation's ability to achieve full growth potential.

Philippe Quevauviller explores the relationship between water sustainability and climate change in more detail in the first chapter. He comments on some of the observations by the Intergovernmental Panel on Climate Change (IPCC) and links this back to the impact and potential effect on the European objectives in moving to sustainable water management where water sources are demonstrably of good quality and of good ecological status. Finally he outlines the key research priorities for Europe in a global context.

In the second chapter, Alan MacDonald and his co-authors highlight the impact of climate change in an African context, exploring some climate change scenarios and their possible outcomes. This chapter then goes on to consider water availability and water stress and makes the link back to better source control and considers changes in demand across the African continent.

Following on from these chapters, Ulrich Borchers and his co-authors discuss the importance of the Water Framework Directive in delivering "good status" for waters in Europe and presents a case study of work carried out to monitor for priority substances in water bodies. This third chapter touches upon some of the analytical challenges that chemists face when developing methods which will allow countries to demonstrate improvements to water quality.

Having discussed environmental change as a driver in the health and sustainability of the ecosystem and water, we must now also consider the changing trend in human behaviour as a driver that influences water sustainability and ecological wellbeing.

There are a number of trends in human behaviour that impact on our environment that should be considered in this debate. These include market forces, population changes, urbanisation, economic growth, price of raw materials, advancements in technology, and the removal and introduction of species within the ecosystem.

Since the industrial revolution, the pace of change on a global scale has increased exponentially, with new technological advances enabling changes to how raw materials are mined, improvement being made in manufacturing

processes and increasing the speed at which knowledge can be shared and applied.

This has many effects, one of which is the change in demand within the population that influence markets. In the United Kingdom, as an example, we expect seasonal perishable goods such as fruit and vegetables to be available all year round. The result of this demand is an increase in imports which drives changes in manufacturing and distribution. In the fourth chapter, Jerry Knox and his co-authors explore the implications that these demands have on the water resources of the exporting nations, and the effect that this can have on our water footprint and food security in the longer term. The chapter also touches on the longer term economic impact of the growing reliance on imported food within the UK which can equally be applied to other countries.

It follows that land use and land management play a crucial role within the ecological framework that supports sustainable water. In many countries across the world we are seeing changes to the population and an increase in urbanisation which impact on land use, ecology, and therefore water resource sustainability. We can see an increasing trend in the use of irrigation and desalination in some water stressed areas. New research and technology is influencing farming practices. New methods of working support changes in woodland and forest management. All of these changes influence the ecosystem and have an impact on water resources. It is therefore critical to understand the relationship between all of these factors when assessing new ideas and research topics that will benefit the sustainability approach.

As the priority and availability of water changes, we must also remember that everyone should have the right to a safe source of drinking water. In chapter five, Adrian McDonald and his co-authors look at social justice at three levels within society. Initially they examine social justice at the corporate level, making the link between land management, farming waste and the impacts on other water users, giving some examples based in Scotland, and link this to the impact on the end consumer. They further explore aspects of individual social justice, considering the impact of debt and deprivation, and use statistics from England and Wales to support their arguments. Finally they consider the position of social justice from a global perspective, considering upland drainage systems and the impact that this has on coastal communities in the longer term.

We have debated some of the drivers for change and the impacts that these have on water availability, which creates local and global challenges in everything from supply of safe drinking water to improvements in land management and carbon reduction. In addition to these aspects of innovation, there are research scientists around the world looking at the longer term with a view to developing technology that will act as an enabler of sustainability.

Both Stuart Khan and Greg Lowry (with his co-author Matt Hotze) in the final two chapters present some new ideas and different approaches to dealing with water availability and removal of contamination, with an objective of maximising the use of recycled water. These techniques and processes will become more important in protecting our freshwater sources in the future. It is

important that we continue to support investment in research and innovation if we are to achieve the objective of safe clean drinking water for the global population.

It is now worth considering policy as a driver for change in moving to a more sustainable water and healthier ecosystem. We can invest any amount of time and money in research, but if this is not supported by good policy then it is unlikely to realise full value and benefit. It is important then, that national governments agree an alignment of policy wherever possible and this should include legislative instruments and well as setting the right taxation levies.

As an example, in Scotland the government has created a Coordinated Agenda for Marine, Environment and Rural Affairs Science (CAMERAS, see www.scotland.gov.uk/Publications/2009/01/21125048/3) which links into the ecosystems services approach. The CAMERAS group is tasked with developing sustainable strategies for science research in the environmental sector and provides an exciting opportunity to align activities that link land management, marine and fresh water ecosystems. The strategies that are in place and under development are aligned to the United Kingdom and European research priorities. It is important that we take every opportunity in finding solutions together and recognise that many challenges cross a range of scientific and engineering disciplines.

Throughout this foreword we have only scratched the surface of the debate around creating a more sustainable approach to water management and we have touched upon some of the key influencing factors and the questions that they present us with.

What we can conclude from this is that water sustainability, climate change, ecological health, population changes, land management, urbanisation and economic prosperity are all intrinsically linked. It is therefore important to recognise that the challenges we face on a global scale can only be resolved by scientists, engineers and policy makers working together to create aligned objectives and strategies.

Richard Allan
Chief Scientist, Scottish Water

Preface

This book series focuses on issues in environmental science and technology which are of particular current interest and concern, as may be seen from the titles of other recent volumes which are listed on an earlier page. Few issues are of greater significance today than the subject of this book – the sustainability of water supplies to the growing populations throughout the world.

It is predicted that climate change will result in big changes to the global distribution of rainfall, causing drought and desertification in some regions but floods in others. Already there are signs of such change occurring, with particularly serious consequences for some of the poorer countries. The need for international cooperation in managing the effects of climate change and other influences on the hydrological cycle is becoming urgent: future wars may well be fought over water.

As is usual for books in this series, we have brought together a group of experts in the subject area to contribute articles covering a wide range of topics which bear on the overall theme of sustainable water. The authors of the seven chapters are drawn from institutions in the UK, Belgium, Germany, Ireland, Australia and the United States and apply their specialised knowledge to a wide range of relevant subjects, including policy making in the European Union, rural water supplies in Africa, chemical monitoring and analytical methods, water use in agriculture, social justice in supplying water, potable water recycling and sustainable water treatment. Although wide ranging, the coverage is not intended to be comprehensive, but the Foreword provides a context and also summarises the content.

The book aims to be useful not only to those in the water industry but more widely to policy makers and planners, researchers and environmental consultants, as well as to students in environmental science, technology, engineering and management courses. There is much here also to interest all concerned with major environmental issues such as climate change and the many other factors which influence the sustainability of water supplies.

Ronald E. Hester
Roy M. Harrison

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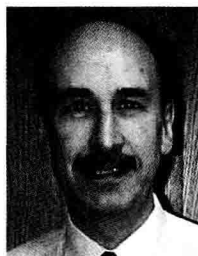
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Editors



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Ronald E. Hester is now Emeritus Professor of Chemistry in the University of York. He was for short periods a research fellow in Cambridge and an assistant professor at Cornell before being appointed to a lectureship in chemistry in York in 1965. He was a full professor in York from 1983 to 2001. His more than 300 publications are mainly in the area of vibrational spectroscopy, latterly focusing on time-resolved studies of photoreaction intermediates and on biomolecular systems in solution. He is active in environmental chemistry and is a founder member and former chairman of the Environment Group of the Royal Society of Chemistry and editor of 'Industry and the Environment in Perspective' (RSC, 1983) and 'Understanding Our Environment' (RSC, 1986). As a member of the Council of the UK Science and Engineering Research Council and several of its sub-committees, panels and boards, he has been heavily involved in national science policy and administration. He was, from 1991 to 1993, a member of the UK Department of the Environment Advisory Committee on Hazardous Substances and from 1995 to 2000 was a member of the Publications and Information Board of the Royal Society of Chemistry.



Roy M. Harrison, BSc, PhD, DSc (Birmingham), FRSC, CChem, FRMetS, Hon MFPH, Hon FFOM

Roy M. Harrison is Queen Elizabeth II Birmingham Centenary Professor of Environmental Health in the University of Birmingham. He was previously Lecturer in Environmental Sciences at the University of Lancaster and Reader and Director of the Institute of Aerosol Science at the University of Essex. His more than 300 publications are mainly in the field of environmental chemistry, although his current work includes studies of human health impacts of atmospheric pollutants as well as research into the chemistry of pollution phenomena. He is a past Chairman of the Environment Group of the Royal Society of Chemistry for whom he has edited 'Pollution: Causes, Effects and Control' (RSC, 1983; Fourth Edition, 2001),

and 'Understanding our Environment: An Introduction to Environmental Chemistry and Pollution' (RSC, Third Edition, 1999). He has a close interest in scientific and policy aspects of air pollution, having been Chairman of the Department of Environment Quality of Urban Air Review Group and the DETR Atmospheric Particles Expert Group. He is currently a member of the DEFRA Air Quality Expert Group, the DEFRA Expert Panel on Air Quality Standards, and the Department of Health Committee on the Medical Effects of Air Pollutants.

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