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INTRODUCTION TO CHAPTER 2: WATER DISTRIBUTION SYSTEMS

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This wide-ranging collection of papers about water distribution highlights the spectrum of issues and challenges facing the supply of water to consumers. The atmosphere of the planet governs the distribution and availability of water; international and national policies influence attitudes and investment in water, whilst living organisms including humans need water to survive. The availability of an adequate supply of the appropriate quality enables health, agriculture, the environment and industry to thrive. In contrast, the lack of water can cause poverty, famine, poor health, forced migration and wars. With the effects of climate change, increased population and pollution, the challenge of supplying water is only going to increase.

It is vital that all communities understand and have the skills, political support and necessary finance to maintain the systems already built. In Oman this includes the historic system of aflaj, which bring water to settlements from the mountains by gravity. It is in the interests of sustainability and carbon reduction that we all maximise the use of existing assets before building new. We must also not 'mine' water but only 'farm' it: drawing out more water than is being replenished is not sustainable and harms wildlife and the ecosystem upon which we all depend. It also then follows that water should be efficiently transported and the leakage minimised.

The first paper, written by El-Naser, makes the compelling case of the significance of groundwater in the Arab Region due to its importance in drinking water supply. Over-abstraction of water leads to reducing quality and quantity of water to the point that the community no longer has a water supply. This leads to instability. As the author argues, this means that international and national organisations must adopt and enforce as a matter of urgency laws and policies for sustainable water practices.

The next paper by Al Dairi and Badr address the important topic of distribution losses which are a waste of money, water resources and the carbon used to clean the water. The framework he proposes presents the use of Lean Six Sigma dimensions as a sustainable utility management method that could be used to manage water utilities. It could also serve as a quality assurance tool for satisfying customer expectations.

Adesogan et al describe why the importance of water to living things cannot be overemphasized. Some of the factors contributing to inefficient water distribution systems in developing countries include low water pressure, intermittent service, and

ageing infrastructure. The aim of the study they report on was to determine, using EPANET and GIS, the hydraulic adequacy of the University of Ibadan's water distribution network. The hydraulic analysis revealed that most pipes have velocities below 1.5m/s, while 82 out of 83 junctions have pressures which are within the prescribed standards. The authors recommend that hydraulic pumps should be introduced into the system in place of distribution by gravity to keep the velocities between the recommended values.

Al-Mamary writes about the change in flows over the years of records in Aflaj in Oman and proposes this is a consequence of climate change reducing the rainfall and increasing the temperature. Aflaj are historic channels and tunnels leading groundwater by gravity from sources in the mountains to areas of demand. Over the years these have been useful sources of water supply but many of the Aflaj have been neglected, leaving them in need of repair. Maintenance of systems is vital to keep capacity and efficiency. The paper shows the reduction in the flow in many Aflaj over the past years of record keeping.

Mandiartha et al aim to investigate the sustainability issues, the current situation and practice, and the challenges of designing a water supply in Mount Rinjani Lombok, Indonesia to support the tourism industry. The water supply is to the Sembalun climbing track ascending from 1100 metres above mean sea level (MAMSL) to 3,726 MAMSL. The current water availability, the predicted future demand, the hydraulic analysis, and the adoption of the World Bank's design process of rural water supply system form the basis of the facility design presented in the paper.

Between them, these papers ably demonstrate that having a water supply and knowing how to treat it to make it potable are insufficient for a sustainable water supply system. First, we have to make sure that we do not over-exploit the supply and, in the first paper, El-Naser expertly demonstrates the adverse consequences of over-abstraction of groundwater.

Then, we have to be able to move the water to the consumers. And just moving it isn't enough either. For a sustainable water future, we have to do so effectively, efficiently and, in ways that are low carbon and as benign as possible to the wider environment.

As with Chapter 1, I hope that all these papers stimulate your own ideas for improvement activity, from applying results you have learnt to your own work to perhaps identifying issues and opportunities for improvement in your own area and seeking out collaboration partners to make a positive step towards a sustainable water future.