<u>WATER STEWARDSHIP – INDUSTRY'S OPPORTUNITY</u>

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The international industrial sector, whether funded by governments or the private sector, can significantly reduce the use of freshwater by installing relatively simple and proven water treatment systems that use stormwater, greywater, and rainwater to replace freshwater use.

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There is an increasing global shortfall of freshwater (also referred to as drinking water or potable water) versus demand. This shortfall is projected to be at 40 percent by 2030, and close to four billion people will live in areas of high water stress (WRG 2012). Therefore, governments, the private sector large and small, and civil society must use and manage water more efficiently.

Agriculture is the largest consumer of water, followed by energy-generating technologies (ES & T 2010; Schelmetic 2012). Agriculture accountsfor about 70 percent of annual global freshwater withdrawals and up to 90 percent in some parts of Asia. However, governments across Asia will also need on average 65 percent more freshwater withdrawals for their industry and energy sectors by 2030 in order for their national economies to grow as forecast (WRG 2012).

The energy sector accounts for 15 percent of the world's water use (IEA 2012). Water is critical for electricity generation. Thermoelectric power plants account for almost fifty percent of all freshwater withdrawals in the US (Kenny et al. 2009) The extraction, transport and processing of fossil fuels requires enormous amounts of water. Moreover, unconventional oil and gas production by methods such as hydrofracking are water-intensive, and has markedly increased over the past five years. Water shortages in India and the United States, among other countries, have limited energy output in the past two years (IEA 2014).

The international industry sector, and particularly agricultural and energy industries, whether funded by governments or the private sector, can significantly reduce the use of freshwater by installing relatively simple and proven water treatment systems that use stormwater, reclaimed water, greywater, and rainwater to replace freshwater use. Although the treatment systems will require an initial capital cost, in many cases this capital cost will be recaptured within several years of installation. Cost recapture will be accelerated where treatment systems service entities that require over one million gallons per day (gpd) water, such as food processing (e.g., sugar) (Sugarcane.org 2013; Gerbens-Leenes and Hoekstra 2009), coal-fired power plants (DOE 2007), pulp and paper mills (EPA 2008), steel mills (UMN 2011; IPST 1995), and data centers (Winslow, B. 2014; Miller, R. 2011).

Desalination and reclaimed water have higher treatment costs, yet their supply may be reliable in times of drought (Pacific Institute 2014; Cooley, Gleick & Wolff 2006; Cooley & Ajami 2012).

Reclaimed water, or recycled water, is defined as former wastewater that is treated to remove solids, impurities and pathogens; meets water quality requirements; and is reused for applications such as irrigation, industrial cooling, and aquifer recharge.

Greywater is defined as wastewater that has been used in kitchen sinks, baths, showers or washing machines. It does not include discharge from toilets, which contains human waste; such waste is termed sewage or blackwater.

Other industries with relatively high water consumption include petroleum and chemicals. The three primary uses of water by these industries are process water, cooling, and boiler feed (Ellis, Dillich and Margolis 2001).

Water is primarily used for cooling at petroleum refineries, and most of this water is reused multiple times. During refining, vapors are reduced to liquids in condensers, and coolers are used to lower the temperature of liquid products to permit safe handling. Smaller quantities of water are used for boiler feed, processing, sanitary services, fire protection, and miscellaneous purposes.

Like petroleum refining, the primary use of water in the chemicals industry is for cooling. Many chemical reactions generate heat, and the reaction vessel must then be cooled so that the desired reactions are properly controlled.

WATER TREATMENT SUCCESS STORIES

In the coastal city of Durban, South Africa, Unilever has constructed a wastewater treatment plant for $2.9M US for their dry food goods factory. The plant is capable of treating approximately 500,000 gpd water, utilizing the following steps:

filtration, biological treatment in a membrane bioreactor, and reverse osmosis to remove microbial and biochemical pollutants. The plant processes harvested rainwater, air conditioning condensate, process water from food preparation and cleaning of machinery, and greywater from wash basins and showers. The plant and attendant water efficiency measures enable the factory to operate without the use of any outside water sources. Eighty percent of the factory's water demand is met by onsite recycled water that would have otherwise been discharged to the ocean. Twenty percent is provided by the harvested rainwater and air conditioning condensate water (WRG 2013).

Windhoek, Namibia is located in an area of highlands surrounded by broad desert expanses. Because of limited surface water and groundwater resources, the government was forced to innovate by installing a multi-step wastewater treatment system that generates reclaimed water. The system averages about 4.7M gpd water, and consists of powdered activated carbon dosing, pre-oxidation and pre-ozonation, flash mixing, enhanced coagulation and flocculation, dissolved air flotation, dual media rapid gravity sand filtration, ozonation, biological activated carbon (BAC) filtration, granular activated carbon (GAC) filtration, ultra-filtration (UF), disinfection and stabilization. The reclaimed water accounts for 26 percent of the total water demand. Significantly, the cost of production is virtually the same as the cost of potable water coming from the existing surface water storage (WRG 2013a).

Industry can partner with local municipalities to save millions of gallons of freshwater. A component of Microsoft's data center in Washington USA includes the construction and operation of a water treatment plant that reuses the water from the local farming community's food processing plant. The water is filtered and used to cool the data center; this water is filtered again; and the water is then used to recharge the local aquifer (Miller, R. 2011).

IRRIGATION & INFRASTRUCTURE IMPROVEMENT

A variety of irrigation and infrastructure improvements have proven successful in saving substantial amounts of water and utilizing limited supplies more efficiently. In water-challenged areas such as Saudi Arabia, Australia, Mexico, India, and South Africa, the following techniques have been used:

a) leakage reduction by replacement of leaky pipes and fittings (WRG 2013b), or by pressure management in municipalities through an automated leak detection system, and installation of a network of pressure-regulating valves (WRG 2013c);

b) industrial water metering; low-flow showerheads, taps, and toilets (WRG 2013d);

c) irrigation management and optimization by irrigation scheduling, determination of correct frequency and duration of watering to maximize yield, installation of sprinkler irrigation systems, and establishment and enforcement of quotas (WRG 2013e).

d) replacement of irrigation channels with pipes or lining of irrigation channels. The efficiency of on-farm irrigation systems is enhanced through control of flows and by sophisticated remote monitoring and sensing systems. Such systems have been successfully implemented through the installation of soil moisture probes and computerized monitoring of soil moisture in various soil types present (WRG 2013f).

INFORMATION MANAGEMENT

In recent years, there has been a significant increase in many types of water stewardship projects. Through organizations such as the United Nations or Global Environmental Facility (GEF), project data collection efforts should be standardized (Cooley et al. 2013). The results of these projects should be distributed through a centralized global water data portal (Cooley et al. 2013); the World Bank's database of environmental projects is probably the largest version of something akin to a data portal of this kind. The enormous widespread use of relatively inexpensive smartphones and personal computers can facilitate distribution of project results, which can aid governments and industry sectors through an open access concept of knowledge transfer (Cooley et al. 2013).

COOPERATION BETWEEN NATIONS & EDUCATION

About 45 percent of the world's landmasses are comprised of river basins occupied by two or more nations (Wolf 2002). Globally, there is a dearth of substantive agreements between nations to effectively manage these basins' water quality and quantity. Effective agreements include language to safeguard ecosystems, protect recharge and discharge zones, prevent pollution, monitor water levels and water quality of the watercourse and aquifers, regularly exchange data and information, provide prior notification of planned activities, promote public participation, have access to justice in environmental matters, and complete transboundary environmental and social impact assessments and audits. A template for a model transboundary agreement has been developed using these principles (Gander

2014). The template can serve as a starting point for adopting at least some of these principles in a formalized agreement.

Increased awareness on the local level of basic water management principles is fundamental to promoting positive widespread change. This can be accomplished through education, and community outreach and participation via local, regional, and national government entities and civil society groups (Cooley et al. 2013).

PROMISING RESEARCH AND DEVELOPMENT

Increasingly effective water stewardship demands aggressive research and development of new technologies. The Namib Desert beetle is indigenous to southern Africa where only 1.4 centimeters (0.55 inch) of rain falls annually. The beetle survives by collecting water droplets from morning fog on the bumpy surface of its wings, spread against the damp breeze. The droplets adhere to hydrophilic (water-attracting) bumps, which are surrounded by waxy-hydrophobic troughs. Water accumulates until the droplet weight overcomes the water's electrostatic attraction to the bumps, and it then rolls by gravity down the beetle's back to its mouth parts (NBD 2012; BBC 2012). Researchers at the Massachusetts Institute of Technology and private industry are developing this phenomena for extraction of moisture from the air (MIT 2011; NBD 2012).

Research into effective means of reduction of evaporation has been ongoing for over fifty years (Monsanto 1964). The Monsanto research, and subsequent variations, utilize three dimensional objects such as inert organic pellets that blanket the surface of the water body. The Mt. Baldy Ski Resort in California used hollow plastic balls to cover the surface of their reservoir in September 2013; results are pending (Hunt 2013).

Instead of a physical barrier, the Lake Arrowhead reservoir in Texas has deployed an evaporation-reduction polymer that showed promise in pilot tests (Harte 2014). In order to meet a goal of 10 percent reduction in evaporation, a biodegradable polymer made from hydrated lime and an extract of palm oil is mixed with water, and forms a molecular net that impedes water from escaping into the air. Application of this polymer on the manmade Lake Sahara in a Las Vegas real estate development resulted in a 31 percent decrease in evaporation in 2012 (Environmental Leader 2013).

In a similar use of relatively benign chemical compounds, ethylene glycol-based compounds have been shown to substantially decrease evaporation in the presence of wind; the addition of a water soluble polymer further enhanced its effectiveness (Prime et al. 2012; Patentscope 2014).

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