*Chapter 9*

# WOMEN AND THE WATER-HEALTH NEXUS

***Corinne Schuster-Wallace[1,2,*] and Susan Watt[1,3]***

[1]United Nations University, Institute for Water, Environment and Health, Hamilton, Ontario, Canada

[2]School of Geography and Earth Sciences, McMaster University, Hamilton, Ontario, Canada

[3]School of Social Work, McMaster University, Hamilton, Ontario, Canada

## ABSTRACT

The transmission, burden and prevention of waterborne and water-related diseases intersect at the water-health nexus. It is manifested through over 800,000 preventable diarrhoeal deaths per year in low and middle income countries, 40% of which occur in under-five year olds. Provision of potable drinking water will not solve the problems reflected in these data. Rather, the simultaneous emphasis on drinking water, sanitation and hygiene (WaSH) are essential to protect and promote health and prevent water-related diseases.

When examined through the female lifecycle, it becomes clear that, while there are broad population-based vulnerabilities associated with lack of access to adequate WaSH services (water quantity and quality, food

[*] Correspondence concerning this article should be addressed to Corinne Schuster-Wallace, Senior Research Fellow, UNU-INWEH, 175, Longwood Rd., S#204, Hamilton, Ontario, Canada. L8P 0A1. Email: corinne.schusterwallace@unu.edu and Susan Watt, Professor, School of Social Work, McMaster University, 1280, Main Street West, Hamilton, Ontario, Canada. L8S4M4. Email: wattmns@mcmaster.ca.

security), most vulnerabilities are individual and specific to women and girls. Moreover, these vulnerabilities vary according to lifecycle stage and location.

This chapter seeks to apply a lifecycle framework to WaSH vulnerabilities and the associated health impacts specifically faced by women over time and space. While not a primary contributing factor in all cases, the role of WaSH and the water-health nexus for improving women's health outcomes cannot be ignored, particularly in reaching development targets such as those articulated in the Millennium Development Goals. Our review concludes with policy, research and practice implications for improving women's health outcomes through WaSH.

**Keywords**: Water, Sanitation, Hygiene, WaSH

# INTRODUCTION

## The Water-Health Nexus

> Water is life's mater and matrix, mother and medium. There is no life without water.
>
> *Albert Szent-Gyorgyi (Hungarian Biochemist and 1937 Nobel Prize Winner for Medicine)*

A nexus is a connection, a linkage, most commonly used to describe complex relationships. In this relationship the individual components - water and health - are, in and of themselves, complex. When linked, the complexity multiplies. Water is essential in sustaining life and health[1]. It also can be a direct carrier of illness and death from waterborne diseases[2] and in its pure form, a life saver[3].

Health impacts the quality of water and the access people have, especially in regions where water is scarce[4]. Together they are affected by and impact on

[1] Gleick, P. H. (1996). Basic Water Requirements for Human Activities: Meeting Basic Needs. *Water International,* 21(2), 83-92. doi: 10.1080/ 02508069608686494.

[2] Percival, S. L., Yates, M. V., Williams, D., Chalmers, R., & Gray, N. (2013). *Microbiology of waterborne diseases: microbiological aspects and risks.* Academic Press.

[3] Saravanan, V. S., & Gondhalekar, D. (2013). Water supply and sanitation as a 'preventive medicine': challenges in rapidly growing economies. *Water International,* 38(7), 867-874.

[4] Ibid.

the physical, demographic, economic, social, cultural, and behavioural aspects of their interrelationship.

In this chapter we will explore the multifaceted relationships between water and women's health. We begin by establishing the relationship between water, sanitation, and hygiene - the WaSH triumvirate - and then examine how WaSH affects and is affected by health in the lifecycle stages. Finally, we explore the implications of these relationships to the development of policy, practice, and research initiatives to improve outcomes for women in the water-health nexus.

## WaSH: Water, Sanitation and Hygiene

Water is part of an inseparable triadic relationship with sanitation and hygiene, reflecting the transmission pathways for waterborne and other infectious diseases. Together as WaSH they are keys to establishing and maintaining health for individuals and communities[5]. Diarrhoea deaths linked to WaSH in LMICs were estimated to be responsible for 1.5% of the global burden of diseases in 2012, or 5.5% if only considered in the under-five cohort[6]. The World Health Organization (WHO) estimates that 4% of the global disease burden could be prevented by improving water supply, sanitation, and hygiene[7] and the BMJ has ranked toilets as the number one health intervention in history[8]. Too much or too little water, contaminated or intrinsically unsafe, poor quality sanitation facilities and inadequate hygiene pose serious hazards such as waterborne protozoa, bacterial, and viral diseases, food insecurity, and environmental destruction that threaten the health of individuals and the well-being of communities and nations.

> 3.4 million people, mostly children, die annually from water-related diseases[6].

[5] Thompson, T., Khan, S. (2003). Situation analysis and epidemiology of infectious disease transmission: a South-East Asian regional perspective. *International Journal of Environmental Health Research,* 13 (sup001), S29-S36. doi:10.1080/096031203 1000102 787.

[6] Prüss-Ustün, A., Bartram, J., Clasen, T., Colford, J. M., Cumming, O., Curtis, V., Cairncross, S. (2014). Burden of disease from inadequate water, sanitation and hygiene in low- and middle-income settings: A retrospective analysis of data from 145 countries. Tropical Medicine & International Health, 19(8), 894-905. doi:10.1111/tmi.12329.

[7] World Health Organization. http://www.who.int/water_sanitation_health/facts_figures/en/ Retrieved September 29, 2014.

[8] Ferriman, A. (2007). BMJ readers choose the "sanitary revolution" as greatest medical advance since 1840. 334(7585), 111-111. doi:10.1136/bmj.39097.611806.DB.

The nexus burden (poor health and poor access to WaSH) tends to fall on those already vulnerable and therefore unable to change their situation. More than 700 million people in the world do not have access to improved drinking water sources, defined as protected water sources[9]. In comparison, more than 2.5 billion (or one quarter of the world's population) do not have access to improved sanitation, defined as family-based ventilated improved pit (VIP) latrine or better[10]. Many belong to the "bottom billion" or the 1 billion people in the world living on less than approximately one dollar per day. This is demonstrated through a quintile income assessment of drinking water and sanitation access[11]. Whereas only 11% of the richest population quintile in Sub-Saharan Africa lack access to improved drinking water as defined by the Joint Monitoring Programme, 65% of the poorest quintile lack access. It is a similar picture for sanitation access, with 73% of the richest and only 15% of the poorest having access to be improved or shared sanitation services.

Given that WaSH interventions are likely to prevent more than 30% of the diarrhoea burden[12], the overall lack of access and inequities in access become a health imperative. The cycle of poor health, poverty and lack of access to WaSH is self-perpetuating and difficult to break out of without external intervention[13]. When sick, people are unable to work which translates to a loss of income, may have to spend money on medication, and may not physically be able to access WaSH services depending on their proximity to the home.

[9] World Health Organization and UNICEF. (2014). Progress on sanitation and drinking-water - 2014 update. Retrieved from http://www.unicef.org/gambia/Progress_on_drinking_water_and_sanitation_2014_update.pdf 28 October 2014.

[10] World Health Organization and UNICEF. (2014). Progress on sanitation and drinking-water - 2014 update. Retrieved from http://www.unicef.org/gambia/ Progress_on_drinking_water _and_sanitation_2014_update.pdf 28 October 2014.

[11] World Health Organization and UNICEF. (2012). Progress on Drinking Water and Sanitation: 2012 Update. Joint Monitoring Programme http://www. unicef.org/ media/files/ JMPreport 2012.pdf Retrieved October 20, 2014.

[12] Prüss-Üstün, A., Bos, R., Gore, F. & Bartram, J. (2008). Safer water, better health: costs, benefits and sustainability of interventions to protect and promote health. World Health Organization, Geneva, 2008. Retrieved from http://whqlibdoc. who.int/ publications/ 2008/ 9789241596435_eng.pdf 28 October, 2014.

[13] Schuster-Wallace C. J., Grover V. I., Adeel Z., Confalonieri U., & Elliott S. (2008). *Safe Water as the Key to Global Health.* United Nations University International Network on Water, Environment and Health http://inweh.unu.edu/wp-content/uploads/ 2013/05/SafeWater_Web_version.pdf Retrieved October 20, 2014.

## Women's Life Cycle

A woman's life cycle is most commonly described in terms of her fertility and reproductive role. The full life cycle is much broader stretching from pre-birth to death (Figure 1). For the purpose of this chapter the stages highlighted will be pre-birth (fertilized egg and foetus), infancy and into childhood - the first 1000 days - remaining childhood, teenage years, adulthood, and old age, including death. This is an arbitrary division but one that we believe is useful in thinking about the water-health nexus.

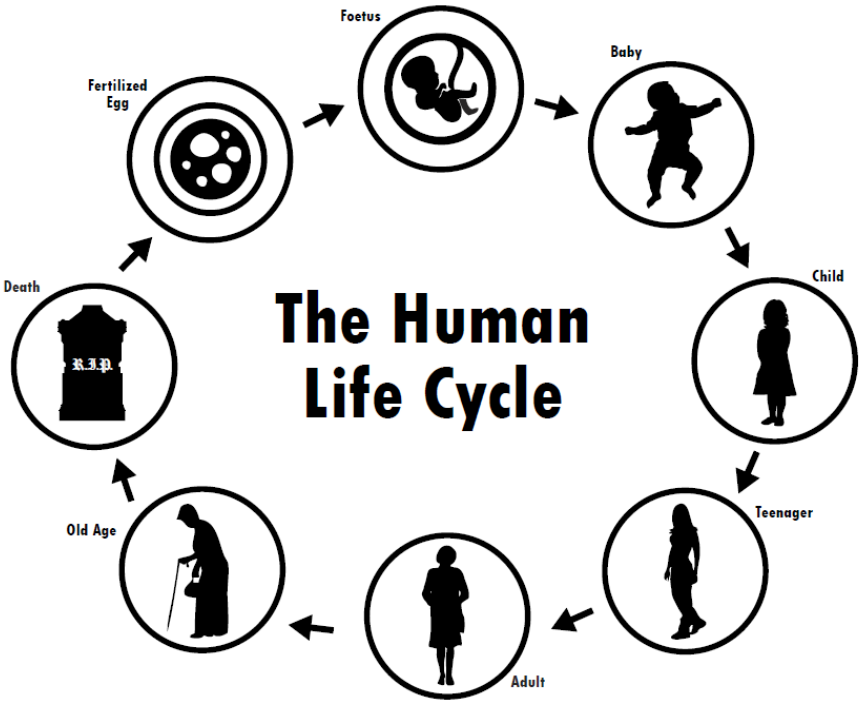


Figure 1. The Life Cycle and Stages.

## DISCUSSION: INTERSECTION OF WASH AND THE FEMALE LIFE CYCLE

## Water and Health

Depending on the method of measurement, waterborne diseases are estimated to cause about 1.8 million human deaths annually[14] and are themselves caused by pathogenic microorganisms that most commonly are transmitted in contaminated water (Figure 2). Infection enters the body directly from drinking or eating foods contaminated by infected water during the preparatory process or on hands that have come into contact with contaminated faeces (fecal-oral route). Additionally, some infections can be transmitted through bathing or washing[15] or inhaled. Other, water-related, diseases include vector-borne diseases in which water is a medium for vector survival, procreation or disease transmission. It is interesting to note that over half of diseases described by WHO as neglected tropical diseases (NTDs) i.e. diseases that affect a significant proportion of the population, are endemic in many countries and yet their eradication are not accorded global priority, are water-related.

[14] Retrieved from http://www.who.int/water_sanitation_health/publications/factsfigures04/en/28 October, 2014.

[15] Nwachcuku N., Gerba, C. P. (June 2004). Emerging waterborne pathogens: can we kill them all? *Current Opinion in Biotechnology*, 15 (3): 175-80. doi:10.1016/j.copbio.2004.04.010. PMID 15193323.

Figure 2. Lack of toilets and solid waste management contaminates drinking water sources and threatens the health, dignity, privacy and safety of women and girls. *Photo used with permission by Corinne Schuster-Wallace.*

Waterborne illnesses include zoonoses (contagious diseases spread between animals and humans) and can be parasitic (caused or transmitted by a parasite), protozoal (caused by protozoa), bacterial (caused by bacteria), and viral (caused by a virus) infections[16]. Waterborne zoonotic infections include amoebiasis, cyclosporiasis and microsporidiosis, as well as the protozoan infections giardiasis and cryptosporidiosis. Waterborne and water-related parasitic infections include schistosomiasis[17], dracunculiasis, taeniasis, fasciolopsiasis, hymenopsiasis, echinococcosis, coenrosis, ascariasis, and enterobiasis. Bacterial infections include botulism, campylobacteriosis, cholera[18], *E. coli*

[16] Dziuban E. J, Liang J. L, Craun G. F., Hill V., Yu P. A., et al. (22 December 2006). Surveillance for Waterborne Disease and Outbreaks Associated with Recreational Water - United States, 2003-2004, *MMWR Surveill Summ.* 55 (12): 1-30. PMID 17183230.

[17] Retrieved from http://www.who.int/schistosomiasis/en/ September 21, 2014.

[18] Retrieved from http://www.who.int/mediacentre/factsheets/fs107/en/ September 21, 2014.

infections[19], *M. marinum* infections[20], dysentery (including *Shigella* infections[21] and salmonellosis[22]), legionellosis[23] (Legionnaires' disease and Pontiac fever), leptospirosis, otitis externa, salmonellosis, typhoid fever[24], and vibrio illness.

Viral infections can be transmitted directly through water or by insects such as ticks and mosquitoes that breed in stagnant water. Dengue fever and malaria are two of the most common viral infections associated with mosquitoes. Other common viral infections that are waterborne or water-related are chikungunya, SARS (Severe Acute Respiratory Syndrome)[25], hepatitis A[26], poliomyelitis, and polyomavirus infection (JC virus and BK virus). The conditions for vector-borne diseases include not only the quality and quantity of water, but its suitability for vector or intermediate host breeding. Moreover, humans must come into contact with either the water itself (e.g. schistosomiasis) or the vector (e.g. malaria) for disease transmission to occur.

The type and frequency of human-water or human-vector interactions and size of population reservoir are important factors for sustaining the disease in a community[27]. In addition to the zoonotic, parasitic, bacterial, and viral infections discussed previously and known generically as vector-borne diseases, water also poses other health risks which can be acute or chronic depending on the concentration in the water and the amount and frequency of consumption. These contaminants include naturally occurring metals and other chemicals such as arsenic and fluoride, as well as anthropogenic contaminants, such as persistent organic pollutants (POPs) used as fertilisers and flame retardants and more recently, pharmaceuticals and ingredients in personal care products (PPCPs). In addition to direct consumption through drinking water, these contaminants can be ingested through crops irrigated with contaminated water. Contaminants tend to bio-accumulate, so that health manifestations may occur years after exposure. Long term exposure to many of these contaminants can

[19] Retrieved from http://www.who.int/topics/escherichia_coli_infections/en/ September 21, 2014.
[20] Petrini, B. (October 2006). Mycobacterium marinum: ubiquitous agent of waterborne granulomatous skin infections, *Eur J Clin Microbiol Infect Dis.* 25 (10): 609-13. doi:10.1007/s 10096-006-0201-4. PMID 17047903.
[21] Retrieved from http://www.who.int/topics/shigella/en/ September 21, 2014.
[22] Retrieved from http://www.who.int/topics/salmonella/en/ September 21, 2014.
[23] Retrieved from http://www.who.int/water_sanitation_health/emerging/legionella_rel/en/September 21, 2014.
[24] Retrieved from http://www.who.int/topics/typhoid_fever/en/ September 21, 2014.
[25] Retrieved from http://www.who.int/topics/sars/en/ September 21, 2014.
[26] Retrieved from http://www.who.int/topics/hepatitis/en/ September 21, 2014.
[27] Retrieved from http://www.fao.org/docrep/w7224e/w7224e0b.htm September 22, 2014.

cause cancer, affect development and/or impact the endocrine system. The most difficult challenge to drinking water supplies and therefore health, particularly in LMICs, is the technology and expense required to remove these contaminants from the water supply; some of the newer anthropogenic contaminants cannot even be measured, let alone removed[28].

## WaSH Interventions

Interventions for reducing waterborne disease in a household and in a community require multi-pronged approaches. This is because many of the pathogens follow a faecal-oral transmission route. This means that once a person is infected, the pathogens are shed in their stools and are transmitted back to themselves or to infect someone else through five main pathways (also referred to as the Five Fs - food, field (or soil), faeces, flies and fingers) (Figure 3). In order to block all of these pathways, faeces must be disposed of in a hygienic manner (i.e. away from contact with people), water must be kept clean or treated to kill pathogens and hands must be kept clean through proposer hygiene practices with soap. If any of these individual elements are not implemented, the effectiveness of the intervention is compromised. Moreover, similar to herd immunity in vaccinations, household implementation will not be as effective as complete community buy in. A single individual practicing open defecation means that there are faeces in the environment that can be washed into drinking water sources during rain events, transferred to food and faeces by flies and played in by children.

Toilets and waste treatment are the first line of intervention to break the faecal-oral transmission route. These facilitate the hygienic disposal of waste so that it does not come into contact with people, and prevents the waste (and therefore pathogens in the waste) from entering the environment and therefore streams, rivers, lakes and oceans. Contaminated water can be treated prior to consumption by removing particulates (filtration) and killing pathogens (disinfection).

[28] Schuster-Wallace, C. J., Dickin, S. K. & Metcalfe, C. D. (2013). Climate Change Impacts on Health: Waterborne and Foodborne Diseases. In *Handbook of Global Environmental Pollution*, Freedman, B. (ed.), Environmental Change and Human Health Series, Brimblecombe, P., Lal, R., Stanley, R. & Trevors, J. T. (eds.) Springer.

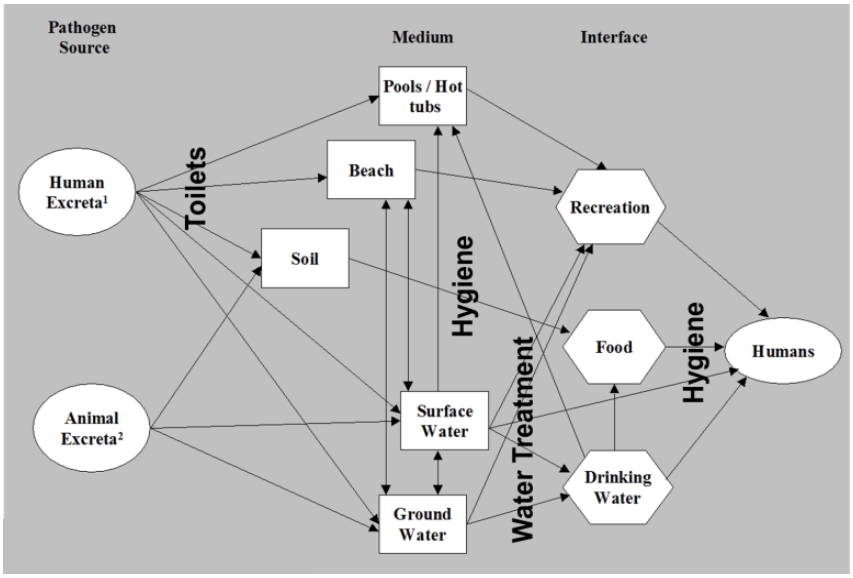


Figure 3. The Five F's and Impact of WaSH Interventions.

Hygiene is extremely important as there are many sicknesses which can be caused by inadequate domestic or personal hygiene and there are many opportunities for contamination and re-contamination of household domestic water supplies to occur. These include using dirty containers to fetch the water and/or transfer the water into once back at the house and retrieving the water using a cup can result in contamination from dirty hands, especially those belonging to children. A dipper or ladle will avoid this type of contamination. More broadly, all family members should wash their hands with soap before food preparation, eating, decanting water and after defecating or urinating and maintain a level of personal hygiene through regular bathing. Signs of poor domestic hygiene include not keeping sanitation facilities clean, not keeping the house and its environs clean from, for example, solid waste, not washing clothes and bedding frequently and not storing food properly.

The spread of disease can be facilitated by misconceptions and lack of knowledge. For example, in many African contexts it is felt that children's faeces do not contain harmful pathogens. As a result, children under the age of three are not encouraged to use the toilet and are expected to practice open defecation. Indeed, children may be actively discouraged because they are seen to leave the toilet facility dirty after use. Ironically, many children are happy to avoid the toilet so that they do not fall in or so that snakes do not come out. This

attitude is taken up by pregnant women, albeit for a different reason - they are afraid that the baby may fall into the pit.

## WaSH Access

Women and girls bear the burden of collecting water in many cultures around the world where water is not piped onto the premises (Figure 4). Inability to access drinking water and sanitation is usually a result of one or more factors associated with physical geography, socioeconomic status or individual ability. From a geographic perspective, water points or toilets may simply be too far away and take too long to get to. Data tell us that women in Sub-Saharan Africa spend an estimated 16 million hours each day collecting water.[29] Moreover, studies have linked distance to reduced water use and increased diarrhoea.[30] Physical distance is not the only issue facing women when they collect water. Topography, or the shape of the land and its features, can also impede water collection. This can change depending on seasons, with some rivers becoming too fast to cross after rain, or paths being too steep and muddy. In addition to impacting on the route taken, weather affects how much water and where it is. Many LMIC countries experience wet and dry seasons and the delay of the wet season, or above average rain can result in droughts and floods, impacting not only where to access water, but crops and therefore food security.

Socio-economic access is created and maintained through inequities and stigma. Some people are considered "unclean" whether through social status or illness, even when that illness comes from the water consumed in the first place (e.g. arsenicosis in Bangladesh[31]). Another way in which access is compromised is through the inability to pay, whether it is from an informal vendor or from a municipality. The irony is that water costs significantly more from informal vendors than it does from centralised systems. Unfortunately, not everyone on centralised systems is able to maintain payments, especially when systems are

[29] World Health Organisation and UNICEF. (2012). Progress on Drinking Water and Sanitation: 2012 Update. Joint Monitoring Programme. Retrieved from http://www.unicef.org/media/files/JMPreport2012.pdf October 20, 2014.

[30] Prüss-Ustün, A., Bartram, J., Clasen, T., Colford, J. M., Cumming, O., Curtis, V., Cairncross, S. (2014). Burden of disease from inadequate water, sanitation and hygiene in low- and middle-income settings: A retrospective analysis of data from 145 countries. *Tropical Medicine & International Health,* 19(8), 894-905. doi:10.1111/tmi.12329.

[31] Hassan M. M., Atkins P. E. & Dunn C. E. (2005). Social implications of arsenic poisoning in Bangladesh Social, *Science & Medicine* 61:2201-2211.

aging and leaking, as experienced in Detroit, Michigan recently[32] and brought to increased public attention by UN experts[33]. This example links to poor management of systems, which can impact assess. Water leaks, broken pipes and water treatment plant failures can be mitigated, if not eliminated, through sound management and investments.

The final barrier to access, even if water and sanitation facilities are available in the home, is that of physical ability to turn on taps or sit on a toilet. This can be exacerbated if a person has to walk to and from a water point and/or carry a 20 litre jerry can, or squat over a pit latrine.

Figure 4. Women and young girls spend hours fetching water in low and middle income countries. The lack of access to WaSH in all its manifestations contributes to lack of education, poverty, early pregnancy and maternal death for many women/girls. *Photo used with permission by Mark Kibirige (Save the Mothers).*

[32] Retrieved from http://www.latimes.com/nation/la-na-detroit-water-20140629-story.html#page=1 21 October 2014.

[33] Retrieved from http://www.un.org/apps/news/story.asp?NewsID=49127#.VEe7diKsX4x24 October 2014.

## WaSH and Food Security

In many parts of the world, the role of subsistence farming, or kitchen gardens, falls to women. Even if they are not responsible for cultivating the food eaten, they are responsible for its preparation. Hygiene practices such as washing hand with soap before preparing food are very important to prevent the spread of disease and proper sanitation can reduce the risk of contamination of crops grown in the field. However human waste can be extremely beneficial for crop production. Both faeces and urine contain key nutrients that increase crop growth - nitrogen, phosphorous and potassium[34] - in sufficient quantities that, if it was all recycled, would reduce demand for fertilizers by 35-45%[35]. Indeed, the waste from a single family in a year can equate to two 50kg bags of fertilizer and grow more and bigger vegetables[36].

However, health risks exist when using human waste for fertilizing crops. In small scale agriculture, the farmer and their immediate family is most at risk, both when applying the fertilizer or wastewater for irrigation and when consuming the food products. Consumers can be at risk when wastewater irrigation is used for commercial farming, as crops are shipped around the world. Stringent regulations, education and monitoring can mitigate these risks so that the benefits of increased productivity per unit area and potential crop diversification can be realized. These benefits can result in improved diet and better nutrition, while excess crops can be sold at a profit.

The "Waste to Wealth" approach currently being tested in Uganda by the United Nations University Institute for Water, Environment and Health through a grant from Grand Challenges Canada, takes this concept one step further. Through a process called anaerobic digestion - the breakdown (digestion) of human waste by bacteria which grow in the absence of oxygen (anaerobic conditions) - human waste is processed into fuel and fertiliser products. These value-added products can be sold to offset capital investments and support expansion of sanitation services, particularly in rural communities[37].

---

[34] Kirchmann, H. & Pettersson, S. (1995). Human urine: Chemical composition and fertilizer use efficiency. Fertilizer Research, 40:149-15.

[35] Lind, B., Ban, Z. & Byden, S. (2001). Volume reduction and concentration of nutrients in human urine Ecological Eng., 16:561-566.

[36] Richert, A., Gensch, R., Jönsson, H., Stenström, T.-A. & Dagerskog, L. (2010). Practical Guidance on the Use of Urine in Crop Production. Stockholm Environment Institute, Sweden. ISBN 978-91-86125-21-9. Retrieved from http://www. ecosanres. org/pdf_files/ ESR2010-1-PracticalGuidanceOnTheUseOfUrineInCropProduction.pdf 27 October, 2014.

[37] Retrieved from http://inweh.unu.edu/waste-to-wealth/ 23 October, 2014.

## WaSH and Medical Care

Both males and females are likely to require medical care at some point during their lives. However, through their reproductive role women are repeatedly placed in a position that may require medical care, or at least the care of a health professional. Care seeking behavior primarily depends on access to a professional and/or health care facility. However, the cleanliness of a facility also plays a role. Women are less likely to seek out formal care if they are more afraid of becoming ill from something else. Further, unclean facilities affect staff morale and professionalism, which is linked to quality of environment and the ability to undertake their jobs[38].

## Life Stages

In addition to these overarching issues associated with WaSH which can occur at any life stage and which impact the entire population, there are many points in the female life cycle where access to WaSH is essential for women and where lack of access can result in physical and psychological harm. These include child development, menstruation and, pregnancy and childbirth (Figure 5).

[38] Leveck, M. L. & Jones, C. B. (1996). The nursing practice environment, staff retention, and quality of care. Res. Nurs. Health, 19:331–343. doi:10.1002/(SICI)1098-240X(199608)19:4<331:AID-NUR7>3.0.CO;2-J.

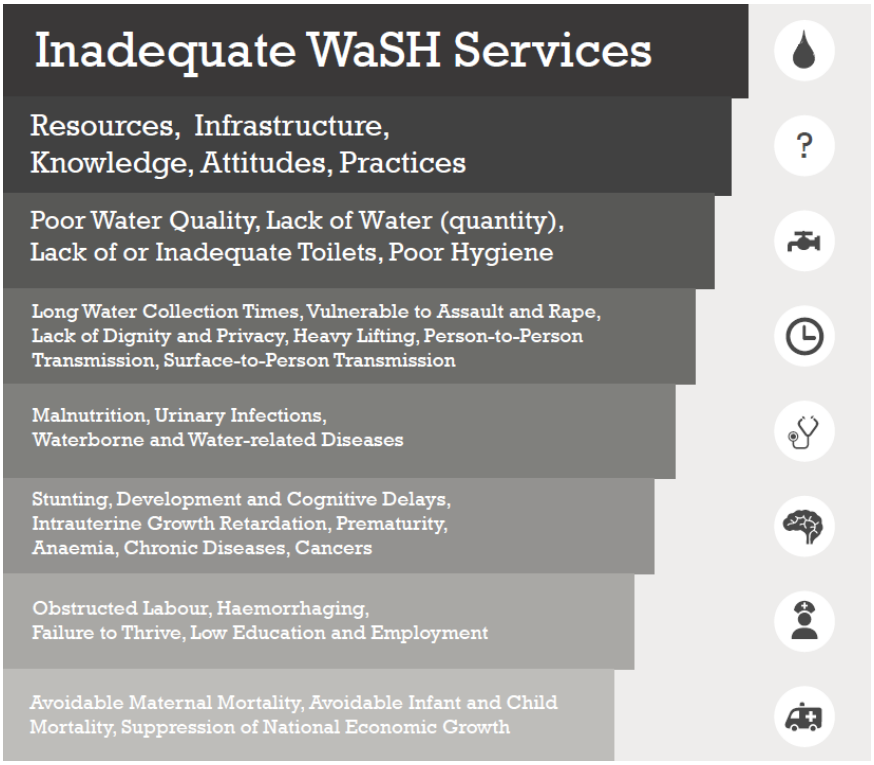


Figure 5. WaSH Impacts through the Life Stages.

### *First 1000 Days (Pre-birth, Infancy, Childhood) and Childhood*

According to FAO, the first 1,000 days post-conception are nutritionally the most important in a person's life[39]. During this period, physical and neurological development is at its greatest. A lack of nutrients during this period has been linked to low birth weight[40], poor cognitive development[41] and stunting[42]. In the short term, this increases the risk of death from diarrhoea and other

[39] Barker, D. J. P. (2004). Developmental origins of chronic disease. *Public Health*, 126(3), 185-189. doi: 10.1016/j.puhe.2011.11.014.

[40] Haddad, L. (2013). How should nutrition be positioned in the post-2015 agenda? Food Policy, 43(0), 341-352. doi: http://dx.doi.org/10.1016/j.foodpol.2013.05.002.

[41] Mullin, P. M. & Incerpi, M. H. Fetal Growth Restriction In Goodwin, T. M., Montoro, M. N. Muderspach, L., Paulson, R., Roy, S. et al. (editors). *Management of Common Problems in Obstetrics and Gynecology*. (Chichester: John Wiley & Sons, 2010), 21-5.

[42] Smith, L., Haddad, L. Reducing Child Undernutrition: Past Drivers and Priorities for the Post-MDG Era. IDS Working Paper 441. http://www.ids.ac.uk/idsresearch/vulnerability-hunger-and-nutrition Retrieved 21 October 2014.

infectious diseases. In utero, these outcomes can be impacted by water-related infections in the mother. Diarrhoea during pregnancy and while breastfeeding will reduce nutrient absorption for both mother and baby, as will schistosomiasis. Malaria can be very dangerous during pregnancy, causing anaemia that can result in premature birth and foetal development issues, such as respiratory and vision impairment and low birth weight.

The acute impacts of diarrhoea include an inability to absorb nutrients which translates into short term malnutrition. However, chronic diarrhoea or multiple acute episodes can result in chronic malabsorption either through sequelae or through a condition known as "leaky gut" syndrome[43] that alters the lining and/or function of the gut, permanently (or at least for the long term) impairing its ability to absorb nutrients.

Other long term impacts include increased risk of obstructed labour and maternal mortality resulting from stunting and poor pelvic development. Cognitive impairment can impact the education level attained by girls. Even if this is not seen as significant to education, the ripples affect the next generation. Women with higher education levels are more likely to implement public health measures that they learn within the community, enhancing the health of themselves and their family[44]. Moreover, if a mother dies a child is at great risk of dying before their 10th birthday[45].

The combined impact of these longer term effects can be felt at the national level through reduced realisation of human potential and lost productivity[46]. Thus, while (lack of) WaSH access can have immediate implications from

[43] Prendergast, A., & Kelly, P. (2012). Enteropathies in the Developing World: Neglected Effects on Global Health. *The American Journal of Tropical Medicine and Hygiene*, 86(5), 756-763. doi:10.4269/ajtmh.2012.11-0743.

[44] Marmot, M., Friel, S., Bell, R., Houweling, T., & Taylor, S. (2008). Closing the gap in a generation: health equity through action on the social determinants of health. *The Lancet*, 372(9650), 1661-1669. doi: Doi: 10.1016/s0140-6736(08)61690-6.

[45] Ronsmans, C., Chowdhury, M. E., Dasgupta, S. K., Ahmed, A., & Koblinsky, M. Effect of parent's death on child survival in rural Bangladesh: a cohort study. *The Lancet*, 375(9730), 2024-2031. doi: http://dx.doi.org/10.1016/S0140-6736(10)60704-0.

[46] Dora, C., Haines, A., Balbus, J., Fletcher, E., Adair-Rohani, H., Alabaster, G., Neira, M. Indicators linking health and sustainability in the post-2015 development agenda. The Lancet(0). doi: http://dx.doi.org/10.1016/S0140-6736(14)60605-X; El-Zein, A., Jabbour, S., Tekce, B., Zurayk, H., Nuwayhid, I., Khawaja, M., Hogan, D. Health and ecological sustainability in the Arab world: a matter of survival. *The Lancet*, 383(9915), 458-476. doi: http://dx.doi.org/10.1016/S0140-6736(13)62338-7; Bicego, G. T. & Boerma, J. T. (1993). Maternal education and child survival: A comparative study of survey data from 17 countries," Social Science & Medicine. 36(9):1207-1227; Retrieved from http://www.wsp.org/content/economic-impacts-sanitation 23 October, 2014.

conception to childhood, the implications can be far reaching and only fully impact later in life.

***Childhood and Adolescence***

Diarrhoea will continue to affect nutrient absorption during this period. Even though physical and neurological growth is slower during these stages, it is still occurring and can be impacted.

At this age girls will be expected to fetch water before and after school. Fetching water does not simply mean getting up, walking along a nice path and carrying the water back. When girls and women head-load water, there can be very negative health effects. It is common to hear people say that men do "heavy work" such as clearing fields, with the implication being that women do comparatively light work. However, buckets of water carried on the head can weigh up to 40 kg, and the ergonomics of water carrying has been shown to have detrimental effects on the development and health of the spine, leading to deformities, arthritic disease and injury[47]. During droughts, or in particularly dry regions, women and girls may have to get to a water point by 3 am in the morning to ensure that there will still be water there. Any later and it will have dried up. Some water sources are shallow ponds, where women must skim a small clear area and use a dipper to fill their water container. For some mountainous communities, the water source may be 2 km downhill, as in Lyantonde district, Uganda. Additionally, water fetching poses higher risk of encountering malaria carrying mosquitos and poisonous snakes as well as encounters with wild animals. It also increases the risk of injury from falls and infections from abrasions. Water carrying is a weight bearing activity that demands caloric expenditure and which impacts upon muscle and bone development. Depending on how close the water source is, girls may miss out on school, which feeds back into the link between education level and uptake of public health measures in the home (see: First 1,000 Days).

Children play in the water, which can increase their risk of contracting schistosomiasis. With more than 90% prevalence in school children around Lake Victoria[48], this level of infection will undermine any school food programmes unless dealt with through drug therapy. Recreational activities and lack of hygiene in water stressed regions can further result in skin rashes,

[47] Page, B.(1966). Taking the strain: The ergonomics of water carrying, *Waterlines* 14(3): 29-31.

[48] Kabatereine, N. B. et al. (2011). Integrated prevalence mapping of schistosomiasis, soil-transmitted helminthiasis and malaria in lakeside and island communities in Lake Victoria, Uganda, *Parasites & Vectors* 4:232.

blindness and other nematode infections. Schistosomiasis and other parasites have been linked to bladder cancer at later stages in life[49].

***Adolescence***

In addition to the above WaSH related vulnerabilities, adolescents face specific vulnerabilities related to menstruation and menstrual hygiene[50]. Many girls of this age are anaemic and poor nutrition will exacerbate this. In locations with poor WaSH access, menstruation adds to the existing burdens. Sanitary cloths have to be washed, water demand for personal hygiene increases, as does the demand for facilities that afford privacy. In some cultures it is offensive for males to see menstrual blood, so latrines with open pits or channels are not acceptable for females to use during menstruation. Schools with inadequate toilet facilities and a place to wash up can mean that girls and female teachers miss up to a week of school each month. About one in ten school-age African girls does not attend school during menstruation, or drops out at puberty because of the lack of clean and private sanitation facilities[51]. For students, this can make advanced schooling difficult and impact the health of their families in the long-term.

Water carrying can bring about additional risks for this age group through increased exposure to assault from men lying in wait for unsuspecting females. This is increased for girls practicing open defecation, who are likely to wait until darkness falls to provide privacy. If a girl becomes pregnant as a result of rape, her physical immaturity can lead to an increased risk of obstructed labour. Another implication of wanting privacy to relieve themselves is that many adolescent girls and women prefer to go out and relieve themselves under cover of darkness. Withholding bodily wastes until a convenient and dignified location can be found can result in urinary infections and dehydration if women purposefully try to limit liquids during the day. Even in schools where toilet facilities exist, if they are perceived to be dirty and dangerous, girls are likely to avoid relieving themselves until they can find a better facility.

---

[49] Salem, S., Mitchell, R. E., El-Alim El-Dorey, A., Smith, J. A., & Barocas, D. A. (2011). Successful control of schistosomiasis and the changing epidemiology of bladder cancer in Egypt. BJU International, 107(2), 206-211. doi: 10.1111/j.1464-410X.2010.09622.x.

[50] Sommer, M. (2010). Where the education system and women's bodies collide: The social and health impact of girls' experiences of menstruation and schooling in Tanzania. *Journal of Adolescence*, 33(4), 521-529. doi: http://dx.doi.org/10.1016/j.adolescence.2009.03.008.

[51] *The Gender and Water Development Report 2003: Gender Perspectives on Policies in the Water Sector* (Loughborough, United Kingdom, Water, Engineering and Development Centre, Gender and Water Alliance, 2003). Retrieved from http://www.genderandwater-alliance.org/reports/GWA%20Annual%20Report.pdf September 21, 2014.

### *Adulthood: Pre Pregnancy*

Women are at particular risk from water related disease since they are the main drawers of water[52]. By the time women without piped water in their homes reach adulthood, they will have been carrying water for many years and have been continually exposed to the risks described in the previous life stages. By this point in time, the weight bearing of water carrying tends to manifest as aching and painful joints and back pain and infections may begin to manifest as cancers.

> An American taking a five-minute shower uses more water than the average person in a developing country slum uses for an entire day[53].

Approximately 30% of calorie consumption is used in water collection[54]. This, along with general poor nutrition and nematode infections, will impact upon a woman's state of readiness to carry pregnancy. Water carrying also takes time away from other (paid) work or subsistence chores, such as food production or household chores of cleaning, washing clothes, food preparation and looking after the sick. Not all women would necessarily fill the time released from water fetching with paid work, or any work, but those who need/want to will have their paid working hours squeezed by the time burden water fetching places upon them. However, there are social benefits associated with water fetching that women value, such as sharing news with women from other communities, teaching younger girls in matters of being a woman, a mother and a wife, and, sharing time away from the home with friends.

### *Adults: Pregnancy, Childbirth and Postpartum*

---

[52] Bradley, D. J., White, A. U. and Gilbert F. White, G. F. *Drawers of Water: Domestic Water Use in East Africa* (Chicago, The University of Chicago Press, 1972). Thompson, J., *Drawers of water: 30 years of change in domestic water use and environmental health in East Africa, summary report*. (London, International Institute for Environment and Development, 2001), available from: http://www.earthprint.com. or from http://www. drawersofwater.org.

[53] http://Water.Org/water-crisis/water-facts/water/, 2015

[54] Mehretu, A. & Mutambirwa, C. (1992). Gender differences in time and energy costs of distance for regular domestic chores in rural Zimbabwe: A case study of the Chiduku communal area, *World Development*, 20(11): 1675-1683.

> Reproductive health is an important issue. It is about the survival and well-being of our families, our cultures and communities, our peoples. It is not just about an absence of illness or disease.
>
> *Thomas Gass, Assistant Secretary-General for Policy Coordination and Inter-Agency Affairs in UN DESA*

Poor WaSH access while pregnant can impact nutrition of both mother and foetus, through diarrhoea. Malaria can result in anaemia and increased risk of haemorrhaging during childbirth, while stunting during early childhood development can lead to obstructed delivery. Heavily pregnant women will have problems with the sheer physical labour associated with fetching water. When pregnant, water carrying takes on another level of difficulty - traversing uneven terrain when you have a different balance point and cannot see your own feet. The alternative is to pay someone to bring the water to you, but that can be prohibitively expensive especially for poorer families. In addition to injury, falling while pregnant can result in miscarriage. Heavy carrying can result in spinal damage in the long term and joint damage during pregnancy because of loosening of joints pre delivery[55].

When in labour, women may have to go and collect water for the home or to take with them to the health care facility. An unclean birthing and post-partum environment can lead to sepsis and other rashes and infections for both mother and baby (Figure 6). After birth, breastfeeding mothers have higher caloric and liquid expenditure that has to be replaced. Poor WaSH can provide an opportunity for waterborne disease infection. This risk extends to formula fed babies.

Finally, there are consequences of pregnancy, especially in LMICs, which can impact water fetching, sanitation and personal hygiene as well as stigmatise a woman. These include prolapses and fistulas.

[55] Juhl, M., Strandberg-Larsen, K., Larsen, P. S., Andersen, P. K., Svendsen, S. W., Bonde, J. P., & Nybo, A. A. (2013). Occupational lifting during pregnancy and risk of fetal death in a large national cohort study. *Scandinavian Journal of Work, Environment & Health*, 39(4), 335-342.

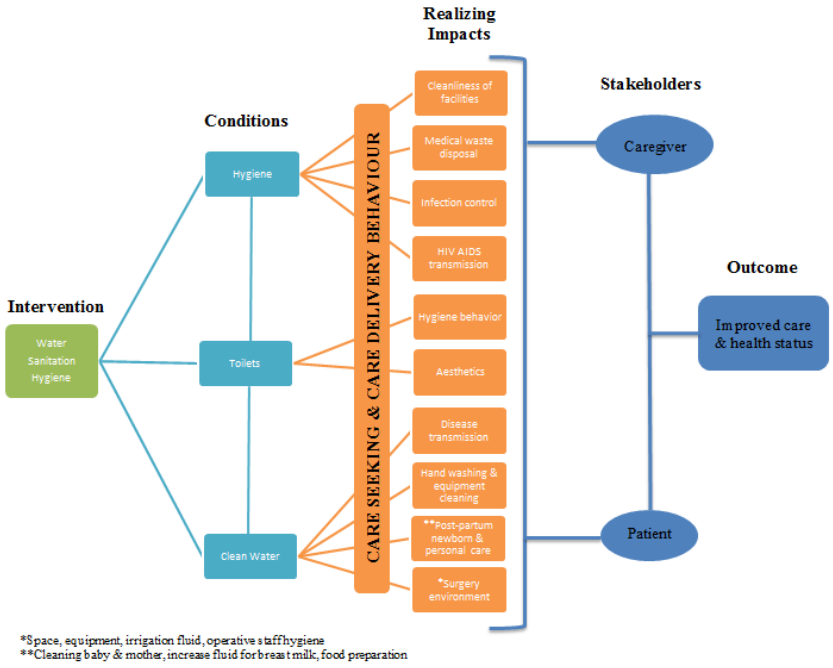


Figure 6. WaSH and Childbirth.

### *Old Age*

A woman in old age will demonstrate the full burden of a lifetime of water carrying and pregnancies. Joint pain and other old age infirmities will impact the ability to carry water. Not only do the financial implications of having someone else fetch it place an additional burden on these women, but family support or the lack thereof goes beyond water carrying to personal hygiene, food procurement and preparation etc. Toilets in particular can be problematic for women in old age who are too weak or physically incapable of squatting for any period of time. Raised toilets, such as ecological sanitation facilities with drying chambers underneath and squat plates can make toilet access impossible to navigate without help. Ramps, hand rails and raised platforms can help make toilets accessible and may overcome a reason why some people prefer open

defecation: when weak from diarrhoea, it is far easier to grab onto a stout branch than squat over a toilet (Figure 7)[56].

Figure 7. Lack of toilets at school keep girls away for a week each month, compromising their education. *Photo used with permission from Corinne Schuster-Wallace*

[56] Levison, M. M., Elliott, S. J., Karanja, D. M. S., Schuster-Wallace, C. J. & Harrington, D. W. (2011) "You cannot prevent a disease; you only treat diseases when they occur": Knowledge, attitudes and practices to water-health in a rural Kenyan community, East Afr. J. Public Health 8(2):103-11.

## Individual Vulnerabilities across the Life Cycle

### *Disability*

As mentioned previously, poor WaSH contributes to poor intrauterine growth development and prematurity and the resulting disabilities can impact on females throughout the life cycle. These women form part of a broader group of females who are either born or become disabled within their life cycle. These women have specific needs and vulnerabilities which transcend the discrete life stages above. Similar to women in old age, accessing sanitation facilities, collecting water or undertaking domestic chores may be beyond their capability, even when facilities have been provided in close proximity to the house.

### *HIV/AIDS Vulnerability*

Women living with or otherwise affected by HIV/AIDs experience an increased burden when it comes to WaSH. HIV/AIDs patients require increased water volumes for medicating, personal hygiene and washing bedding and clothing. While the minimum amount of water per person per day recommended by WHO is 20 litres per person per day, a person living with HIV/AIDs can require up to 100 litres per day[57]. When considering WaSH in the context of other highly infectious diseases, the Ebola crisis points to increased need for water at a rate of 150 to 1300 liters per person per day, up from the 50 litres/day/person normally recommended as the supply rate for water in health care facilities in Africa[58].

Moreover, diarrhoea is a significant cause of death for immune compromised individuals, placing a higher degree of emphasis on hygiene and infection control. When suffering from AIDs, physical infirmity will result in the same access difficulties as women in old age. Women are the primary caregivers of the sick in their families and HIV/AID patients place a significant time burden on these women.

### *Places of Vulnerability*

The times when women are impacted by poor WaSH conditions imply locations where they are particularly vulnerable. For example, when talking about preventing diarrhoea for maximum childhood development, WaSH in the

[57] USAID & World Health Organization. How to integrate water, sanitation and hygiene into HIV programmes. Geneva: WHO Press; 2010.

[58] WHO, 2011. Guidelines for drinking-water quality, 4th edition. World Health Organization, Geneva. Retrieved from http://www.who. int/water_sanitation_health/publications/2011/ dwq_chapters/en/index.ht 28 September 2014.

home is the most critical factor. For menstruating girls, appropriate WaSH facilities in school are important to reduce stigma and absenteeism, thereby increasing retention beyond primary school. For mothers-to-be, WaSH resources in healthcare facilities, specifically in maternity wards are essential to provide a clean environment for both mother and baby, reducing post-partum infection and disease transmission. These local places are superimposed upon other spatial scales; women in low and middle income countries are more likely to die in childbirth than in high income countries[59] and those in rural areas have less access to services than their urban counterparts[60]. WaSH access itself is highly distributed over space, with 40% of people without access to improved drinking water supplies living in Africa and most people without access to improved drinking water and sanitation live in rural areas[61].

### *Indigenous Peoples*

It is well known that socio-economic status is the primary social determinant of health, or the "causes of the causes"[62]. Superimposed on the global pattern of socio-economic inequities i.e. low and middle income countries, as opposed to high income countries, are patterns of sub-national inequities. There are 370 million Indigenous peoples around the world who tend to experience lower socio-economic status and therefore poorer health than their national counterparts in almost all countries[63]. Discrimination, lower life expectancy, violence and sexual violence against indigenous women, increased vulnerability to HIV/AIDS infection, higher maternal and infant mortality rates, lower access to health care, lower levels of WaSH services, and increased levels

[59] Abou Zahr, C. & Wardlaw, T. Maternal mortality in 2000: estimates developed by WHO, UNICEF and UNFPA. WHO, Geneva; 2004.

[60] Houweling, T. A. J. et al., (2007). Huge poor–rich inequalities in maternity care: an international comparative study of maternity and child care in developing countries. Bulletin of the World Health Organization 85(10): 733-820.doi: 10.2471/BLT.06.038588.

[61] World Health Organisation and UNICEF. (2014). *Progress on Drinking Water and Sanitation - 2014 update*. Retrieved from http://www.wssinfo. org/fileadmin/user_upload/resources/ JMP_report_2014_webEng.pdf 20 October, 2014.

[62] Braveman, P. & Gottlieb, L. (2014) The Social Determinants of Health: It's Time to Consider the Causes of the Causes, Public Health Reports, 129(2):19-31.

[63] Retrieved from http://www.un.org/en/development/desa/news/social/promoting-the-well-bein - of-indigenous-peoples.html 27 October, 2014.

of waterborne diseases in indigenous communities[64, 65] are significant challenges facing Indigenous peoples and Indigenous women specifically. As Michael Marmot concludes, "reducing these social inequalities in health, and thus meeting human needs, is an issue of social justice"[66].

## WaSH Disruption

Disruptions in the availability of safe water, sanitation, and hygiene resources occur as a result of natural disasters such as hurricanes, earthquakes, floods and severe droughts, from environmental disasters (e.g., oil spills), and from the failure of constructed systems as a result of civil unrest, sabotage, terrorism, or accidents. These disruptions can occur without warning or after a significant period of stress on the systems. In some instances they constitute disaster which Wisner et al. describe as events in which "hazards meet vulnerability"[67]. In both instances, although the timeframe varies, the resolution falls somewhere on the spectrum of prevention, mitigation, preparedness, response, and recovery.


*Prevention* measures such as levees[68], (re)forestation programs[69], and disaster- resistant building programs[70] including earthquake tolerant buildings[71], while not directly preventing the event, prevent impacts (e.g., floods, building collapse) which in and of themselves threaten the health and

[64] UN Permanent Forum on Indigenous Issues. (2006). Report of the Meeting on Indigenous Peoples and Indicators of Well-Being. Ottawa, 22-23 March 2006 E/C.19/2006/CRP.3 20 April 2006. Retrieved form http://undesadspd.org/IndigenousPeoples/Meetingsand Workshops/IndicatorsofWellbeing.aspx 27 October, 2014.

[65] Retrieved from http://www.un.org/en/development/desa/news/social/promoting-the-well-being-of-indigenous-peoples.html 27 October, 2014.

[66] Marmot, M. (2005). Social determinants of health inequalities, Lancet 365:1099-104.

[67] Wisner, B., Blaikie, P., Cannon, T. & Davis, I. (2004). *At Risk: Natural hazards, people's vulnerability and disasters.* Wiltshire: Routledge.

[68] Petroski, H. (2006). Levees and Other Raised Ground, *American Scientist* 94 (1): 7-11.

[69] Van Lavieren, H., Spalding, M., Alongi, D., Kainuma, M., Clüsener-Godt, M., and Adeel, Z. 2012. Securing the Future of Mangroves. A Policy Brief. UNU-INWEH, UNESCO-MAB with ISME, ITTO, FAO, UNEP-WCMC and TNC. 53 pp. http://inweh.unu.edu/wp-content/uploads/2013/05/Securingfuturemangroves.pdf Retrieved October 20, 2014.

[70] NEWS: Pakistan's Punjab builds model villages to withstand disasters, *Climate & Development Knowledge Network*, 17 December 2013.

[71] http://www.nehrp.gov/pdf/acehr_charter_signed.pdf Retrieved 10 October 2014.

welfare of a community. Munich found that while low income countries experience only 9% of natural disasters they account for 48% of the resultant fatalities most often affecting women and children[72]. In these countries, prevention is almost ignored.

When prevention fails, or is not possible, *mitigation* (often blended with prevention) includes activities such as emergency shut-off valves to prevent flooding, potable water storage tanks, warehoused hygiene supplies, portable toilets, and housing (e.g., trailers, tents), and tornado shelters. These activities reduce the impact of the WaSH disruption on individuals and property.

*Preparedness* can come in the form of plans (e.g. urban evaluation plans) and specific, designated resources (e.g., in home emergency supply kits). It assumes that lessons have been learned about the nature and likelihood of a specific disaster and its impact (e.g., the loss of clean water during floods, contamination of water supplies from sewer overflows) and the appropriate steps that can be taken to ensure that adequate WaSH resources are made available (e.g., access to emergency generators to pump water, port-a-potties, communal washing areas). Since many LMICs cannot meet the day-to-day demands for WaSH, preparedness for a disruption in the meager existing supply is virtually impossible and may, in part, account for the high levels of morbidity and mortality experienced in these countries (e.g. outbreaks of typhoid form contaminated water).

*Responses* to disruptions in WaSH depend on the resilience of both individuals and communities[73]. In high income countries, although costly, infrastructure is repaired and restored to service in relatively quick order. In the extreme, extensive emergency services such as camps may be required[74] to house either internally displaced or refugee populations. As of 2012, 40.5 million people lived in such settlement worldwide. Residents may stay for weeks or years depending up the ability of their previous home area to achieve at least minimal recovery and stability especially in relation to WaSH provision[75]. But these camps have their own WaSH problems[76].

---

[72] Munich, R. (2012). Münchener Rückversicherungs-Gesellschaft, Geo Risks Research, NatCatSERVICE, from presentation entitled "Natural catastrophes in economies at different stages of development," January 2012.

[73] World Bank. (2013). *Building Resilience: Integrating climate and disaster risk into development. Lessons from World Bank Group experience*. Washington, DC: The World Bank.

[74] http://unhcr.org/globaltrendsjune2013/UNHCR%20GLOBAL%20TRENDS%202012_V05.pdf Retrieved 19 October 2014.

[75] Yonetan, M. (June 2012). Global estimates 2011: *People displaced by natural hazard-induced disasters*. Geneva: Internal Displacement Monitoring Centre, Norwegian Refugee Council.

[76] Retrieved from http://www.who.int/mediacentre/news/releases/2013/South-Sudan-displaced-people-20131231/en/ 19 October 2014.

In addition to the natural disaster which account for significant WaSH disruption, acts of war, terrorism, and sabotage also threaten the flow of uninterrupted WaSH provisions and are most likely to affect middle and high income countries where services are well established and citizen expect to turn on taps, flush toilets, and have access to personal washing facilities.

The Pacific Institute has examined the ways in which water becomes involved in conflict identifying six categories of water-related conflict as follows:

1. Control of Water Resources (state and non-state actors): where water supplies or access to water is at the root of tensions.
2. Military Tool (state actors): where water resources, or water systems themselves, are used by a nation or state as a weapon during a military action.
3. Political Tool (state and non-state actors): where water resources, or water systems themselves, are used by a nation, state, or non-state actor for a political goal.
4. Terrorism (non-state actors): where water resources, or water systems, are either targets or tools of violence or coercion by non-state actors.
5. Military Target (state actors): where water resource systems are targets of military actions by nations or states.
6. Development Disputes (state and non-state actors): where water resources or water systems are a major source of contention and dispute in the context of economic and social development[77].

Since the groupings are defined in part by who caused the problem, the groups overlap and the designation of a particular event into any one category will depend on a political analysis of the cause(s). However preventing, mitigating, responding, and recovering from such events must take into account the surrounding circumstances. Putting back a water main is not likely a priority in a country at war and may indeed be used as part of wartime activities to wear down the resilience of the population at large.

Physically, a community deprived of WaSH bears serious immediate and long-term costs. Loses due to water damage (e.g., in flooding) are often high and unaffordable for the average citizen without external help. Household insurance, where it exists, often excludes water damage from its benefits. The cost of replacing property can be a major response hurdle.

[77] Retrieved from http://worldwater.org/water-conflict/ 20 October 2014.

Procuring safe water becomes a focus of individual, family, and community activity to the detriment of other tasks such as school attendance or paid labour. What was once a clean safe water supply, occurring naturally (e.g., open water source) or through manmade interventions (e.g., pumped water) can no longer be trusted. As discussed previously, attending school or working in the labour force is directly influenced by the WaSH status of the area, especially for women and children. The rise of infectious diseases as a result of disrupted sanitation is particularly risky for already vulnerable groups. Typhoid and salmonella are the two most common outbreaks when WaSH is compromised both resulting from feces-contaminated water which is common when either water or sanitation systems are overwhelmed and basic hygiene ignored. Open defecation becomes preferable to dirty and ill-kept temporary sanitation facilities (e.g., open pit latrines).

Excess water also poses the problem of "out-of-area" species which threaten animal and human safety. Animals which shared water-land environments (e.g., alligators, crocodiles, some snakes) many may be trapped in one environment or transgress into unfamiliar territory. Water fetching and open defecation become even more risky than usual in these circumstances.

The (re)building of infrastructure including WaSH, housing, educational, and health resources is required.

Psychologically, disruption in WaSH unsettles usual social interactions. In communities with significant social capital disruptions can lead to a sharing of resources both within the community and from outside communities (e.g., international aid relief) but comes at a cost of giving up entitlement and self-worth. Choice is restricted and recipients are expected to be grateful for any assistance. The sense of security and well-being that is established in day-to-day routines and expectations is shattered. A psychological crisis state characterized by confusion, withdrawal or unfocused activity, and indecision is often present[78].

*Recovery* is often a long and expensive process in which systems must be restored and the physical and psychological well-being of residents re-established. It starts with recognizing the type and extent of the disruption. The bigger the problem, the more complex, costly, and complex the response must be. A flood in an uninhabited area may have long-term repercussions but not the urgency of the same event in populated areas. Securing of individuals from physical harm is the first priority. Securing adequate safe water and secure

[78] Wisner, B., Blaikie, P., Cannon, T. & Davis, I. (2004). *At Risk: Natural hazards, people's vulnerability and disasters.* Wiltshire: Routledge.

sanitation and hygiene is the second priority to avoid disease outbreaks and further injury. Other infrastructure which includes but is not limited to water, sanitation and hygiene (e.g., schools, health care facilities). This recovery phase can be longer than necessary because of the disconnect which often exists between emergency response efforts and post-disaster recovery.

Finally, recovery from the psychological impacts of the disaster and its disruption in WaSH can take a significant period and resources. Not everyone will have a crisis response to disruptions in WaSH but many individuals may respond in this way. Crisis reactions include emotional turmoil, physical symptoms such as headaches, nausea or chest pain, flashbacks to the event, poor concentrating, impaired decisions making, poor appetite, disrupted sleep, anniversary reactions, and strained interpersonal relationships[79]. Recovery can only be achieved when some sense of a normal balance is achieved by the individual.

## CONCLUSION

We have argued in this chapter that women bear a significant and specific burden related to inadequate WaSH services and that during different stages of their lives, these burdens change in their nature and in their impacts on the vulnerabilities and health status of women. This reality is amplified by where they live and their social status. Being born into poverty heightens the vulnerabilities and risk associated with both WaSH inadequacies and the perils attendant in each life stage. Similarly, pre-existing conditions, often with WaSH antecedents, increases vulnerability even further. Stanley notes,

> The sum of the challenges and risks faced by WLWHA in LMICs is the tragic reality that, at the time of pregnancy and childbirth, these women are more likely to die from simple, preventable causes than their non-HIV/AIDS infected counterparts, who are already at far greater risk than their counterparts in high income countries[80].

The most vulnerable stages are during childbirth and the first 1000 days of a girl's life, while for both, health care facilities equipped with adequate WaSH provisioning mitigates these vulnerabilities.

[79] Retrieved from http://apa.org/topics/disasters/ 19 October 2014.

[80] Stanley, C. 2014. *Improving Women's Wellbeing through a Trans-sectoral Approach: An NGO Framework for Development within the Context of HIV/AIDS and WaSH.* MA, McMaster.

In addition to these direct burdens, women face vulnerabilities that are shaped by their roles and relationships in gendered societies[81]. These roles have been categorized by Moser as a reproductive, productive (e.g., water fetching), and community management roles (e.g., water committees)[82]. Women become more vulnerable when they bear all of the responsibility and none of the decision making authority (e.g., bearing children without the authority to authorize their own care). Gender analysis helps identify and understand these risks and illustrates how working towards gender equality should involve benefits to both men and women[83].

Great strides have been made in reducing maternal and child mortality as well as increasing access to improved drinking water, mainly as a result of the Millennium Development Goals initiatives. We have developed technologies which overcome the physical challenges of water and sanitation provision and are learning to apply appropriate solutions based on our understanding of what works where. We have constructed innovative ways to overcome financing and behavior change barriers to sustainable interventions, especially in LMICs.

Despite these advances, sanitation has not, and will not, reach the MDG target of decreasing by half the number of people without access to adequate sanitation, some women still have to travel to collect water[84] and too many women continue to die unnecessarily in childbirth. Even where global targets have been met (e.g., MDG 4- maternal mortality reduction) a large gap remains between reductions in high income and low income countries and between urban and rural outcomes.

Slowly the progress that is being made on the ground is being encoded in national and international policies. For example, in 2010 the United Nations General Assembly passed a resolution making water and sanitation a human right[85]. While it is recognized that this will not happen overnight, progressive

[81] UN DESA. (2005). Women & Water. (Series Women 2000 & Beyond) Retrieved from http://www.un.org/womenwatch/daw/public/Feb05.pdf 28 October 2014.
[82] Moser C. O. Gender planning and development. New York: Routledge; 1993.
[83] UN DESA. (Feb. 2005). Women & Water. (Series Women 2000 & Beyond) Retrieved from http://www.un.org/womenwatch/daw/public/Feb05.pdf 28 October 2014.
[84] World Health Organization and UNICEF. (2014). Progress on sanitation and drinking-water - 2014 update. Retrieved from http://www. unicef.org/gambia/Progress_on_drinking_water_ and_sanitation_2014_update.pdf 28 October 2014.
[85] UN General Assembly. 2010. 64/292. The human right to water and sanitation. A/RES/64/292 Retrieved from http://www.un.org/es/comun/docs/?symbol=A/RES/64/292&lang=E 28 October 2014.

realization[86] alongside existing gender and pro-poor policies in WaSH and healthcare access provides a feasible pathway for success.

> If we are to address this unacceptable gap between our aspirations and the reality on the ground, we must redouble our efforts to ensure closer collaboration between the UN system, Member States and indigenous peoples.
>
> *Thomas Gass, Assistant Secretary-General for Policy Coordination and Inter-Agency Affairs, UN DESA*

Where do we go from here? Understanding the pathways by which WaSH impacts upon women's health and identifying when and where women are most vulnerable is a critical first step. Now we need to focus on sharing solutions and experiences for scale up and out of interventions that maximize improvements in women's health outcomes. A large part of this is understanding what doesn't work, and where, to ensure that technology transfer, in particular, is appropriate and affordable. Technology transfer and innovation also requires adaptation to local conditions, particularly when transferring to low resource settings. This may include ensuring optimisation using alternative energy sources, or elimination of power supplies altogether, as in the case of incubators made out of hi-tech material and heated with paraffin wax bricks[87]. Monitoring is the final ingredient to be able to ensure iterative learning and adaptation. This must be cheap and effective and preferably in real-time. Advances in, and innovative application of, information and communication technologies (ICTs) and remote sensing are bringing this closer to reality, for example, through the ability to monitor toilet use and hand washing in a hospital in Uganda[88], or to monitor newborn vitals using a cellular phone[89].

However, there are steps that can be taken now. The role of universal WaSH access has to be recognised in our efforts to save the lives of mothers and children. If this is the case, then it follows that all schools and healthcare facilities (existing and future) must be equipped with clean water and adequate sanitation and marginalised populations should be prioritised when it comes to

[86] De Albuquerque, C. with Roaf, V. (2012). On the Right Track: Good Practices in Realising the Rights to Water and Sanitation, Retrieved from http://www.ohchr.org/documents/issues/water/bookongoodpractices_en.pdf 28 October, 2014.

[87] Retrieved from http://embraceglobal.org/embrace-warmer/ 28 October, 2014.

[88] Momen, K. & Fernie, G. R. 2010. Nursing activity recognition using an inexpensive game controller: an application to infection control, *Journal of European Society for Engineering and Medicine* 18:6, 393-408.

[89] Tomlinson, M., Rotheram-Borus, M. J., Doherty, T., Swendeman, D., Tsai, A. C., Ijumba, P. & Chopra, M. (2013). Value of a mobile information system to improve quality of care by community health workers. *SA Journal of Information Management* 15(1), 9-pages.

access in the home. Finally, hygiene training for, and dissemination of good practices by, professional health care workers is essential, especially when caring for mothers and their babies[90].

The safeguarding of women's health, particularly at times of greatest vulnerability, requires that practice, policy and research are inextricably linked to and informed by each other. This, in turn, requires transdisciplinary approaches to solving real-life problems. It requires multi-stakeholder participation between governments, NGOs, the private sector, communities and research institutions, and evidence-informed decision-making. Finally, it requires us to walk alongside women in communities, in schools and in health care facilities, asking the questions and seeking solutions together.

> Is it too late to prevent us from self-destructing? No, for we have the capacity to design our own future, to take a lesson from living things around us and bring our values and actions in line with ecological necessity. But we must first realize that ecological and social and economic issues are all deeply intertwined. There can be no solution to one without a solution to the others.
>
> *Jean-Michel Cousteau (Environmentalist and Film Producer)*

## ACKNOWLEDGEMENTS

Carly Popenko supported by Sabnam Mahmuda, Graphic Design

## REFERENCES

Bartram, J., & Cairncross, S. (2010). Hygiene, sanitation, and water: Forgotten foundations of health. *PLoS Med, 7*(11).

Benova, L., Cumming, O., & Campbell, O. M. R. (2014). Systematic review and meta-analysis: association between water and sanitation environment and maternal mortality. *Tropical Medicine & International Health, 19*(4), 368-387. doi: 10.1111/tmi.12275.

Cheng, J.J., Schuster-Wallace, C., Watt, S, Newbold, K.B. Mente, A. (2012). An Ecological Quantification of the Relationships between Water,

[90] Schuster-Wallace, C. J., Watt, S., & Chamberlain-Froese, J. (2014). Of Taps and Toilets and Safe Motherhood. Retrieved from http://www.savethemothers.org/blog/of-taps-and-toilets-and-saving-mothers#.VFAHF_nF9vk 28 October, 2014.

Sanitation and Infant, Child, and Maternal Mortality, *Environmental Health* 11:14.

Clasen, T., Pruss-Ustun, A., Mathers, C. D., Cumming, O., Cairncross, S., & Colford, J. M. (2014). Estimating the impact of unsafe water, sanitation and hygiene on the global burden of disease: evolving and alternative methods. *Tropical Medicine & International Health*, *19*(8), 884-893. doi: 10.1111/tmi.12330.

Pruss-Ustun, A., Bartram, J., Clasen, T., Colford, J. M., Cumming, O., Curtis, V., Cairncross, S. (2014). Burden of disease from inadequate water, sanitation and hygiene in low- and middle-income settings: A retrospective analysis of data from 145 countries. *Tropical Medicine & International Health*, *19*(8), 894-905. doi:10.1111/tmi.12329.

Say, L., Chou, D., Gemmill, A., Tunçalp, Ö., Moller, A.-B., Daniels, J., Alkema, L. (2014). Global causes of maternal death: a WHO systematic analysis. *The Lancet Global Health*. Published online May 6, 2014 http://dx.doi.org/10.1016/S2214-109X(14)70227-X.

Watt, S., & Chamberlain, J. (2011). Water, climate change, and maternal and newborn health. *Current Opinion in Environmental Sustainability*, 3(6), 491-496. doi: 10.1016/j.cosust.2011.10.008.