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Review

Contracting infectious diseases in Sub-Saharan African wetlands: A question of use? A review

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ABSTRACT

Worldwide the pressure on water is increasing. In parts of Sub-Saharan Africa (SSA), natural wetlands constitute the only accessible water resources, providing water free of charge, agricultural potential and livelihoods in otherwise uninhabitable landscapes, which is why they are being used extensively. The degradation and contamination of water which result from the use of wetlands has the potential to spread disease-causing microorganisms and provide increased breeding habitats for disease vectors, Despite this importance, case studies are lacking and knowledge gaps remain about whether and how different kinds of wetland use influence the exposure to health risks and transmission of infectious diseases.

This descriptive literature review aimed at identifying publications from peer-reviewed journals and book chapters that (i) address water-related infectious diseases in SSA wetlands and (ii) link those diseases to use-related exposures. The resulting overview includes 27 publications and shows that depending on the type of use, people in wetlands are exposed to different risk factors and water-related infectious diseases. Exposure to infectious agents depends on occupational characteristics, and time spent in wetlands. Disease transmission is driven by users' contact to water, characteristics of pathogens and vectors of disease. The amount of available literature varies significantly. Whereas several publications have linked crop production and the domestic use of wetland water to contraction of diseases, fewer are available on health risks identified with pastoralism in wetlands and other uses. Some risk factors are well researched, such as irrigation schemes favouring schistosomiasis prevalence. For others, including proximity of pastoralists to their livestock and the associated trachoma risk, knowledge remains limited.

This review establishes connections of selected diseases with different transmission pathways that are linked to specific risk factors, transmission pathways and resulting diseases. All of these have been integrated into a detailed conceptual framework which simplifies the complexity of the relationships, while at the same time identifying missing links which might provide stimulus for future research tackling the potential research gaps. It concludes that socio-cultural and behavioural considerations regarding the wetland users are not sufficiently evaluated and should receive increased attention in future investigations.

1. Introduction

Worldwide and particularly in Sub-Saharan Africa (SSA), the pressure on the most precious resource of all – water – is increasing. As populations are growing and need to be fed, water becomes ever more essential for survival. In environments, where water is scarce, fragile ecosystems need to be tapped for the water resources. There, wetlands often constitute the only accessible water resources, providing water free of charge and agricultural potential in otherwise uninhabitable landscapes (Dixon and Wood, 2003, Finlayson et al., 2015; Horwitz et al., 2012; McCartney and Rebelo, 2015; Silvius et al., 2000).

Wetlands are broadly defined and include swamps and marshes, lakes and rivers, wet grasslands and peatlands, oases, estuaries, deltas and tidal flats, near-shore marine areas, mangroves and coral reefs, and human-made sites such as fish ponds, rice paddies, reservoirs, and salt pans (Ramsar, 1971). They constitute a resource of great economic, social, cultural, and recreational value (Sakané et al., 2011). Such ecosystems fulfill diverse ecological functions, have direct and indirect benefits, and provide fundamental ecosystem services, thereby directly and indirectly impacting on human health (Cook and Speldewinde, 2015; Horwitz et al., 2012; Parkes and Horwitz, 2008; Stevens, 2010; Turner et al., 2000; Zedler and Kercher, 2005). On a regional and local level, they are extraordinarily important life-support systems and beneficial places from which individuals, communities and populations

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derive their livelihoods (Finlayson et al., 2015; Horwitz and Finlayson, 2011; Horwitz et al., 2012; MEA, 2005a; Mitchell, 2013; Rebelo et al., 2010).

In SSA, natural wetlands are being traded as food baskets with an immense productive potential, attracting people by promising abundant water resources, food security, land, ecosystem services and prosperity (Amler et al., 2015; Finlayson et al., 2015; Horwitz et al., 2012b; McCartney and Rebelo, 2015; Silvius et al., 2000). As a consequence, such ecosystems are becoming subject to increasing in-migration and extensive use: for agricultural crop production, livestock farming and pastoralism, fishery, the collection of natural materials, and the extraction of surface water for domestic use and drinking. It is this extensive use, however, which threatens to deplete the capacities of wetlands, making them become more and more 'unhealthy', contributing to the degradation and contamination of water through the reception of wastewaters and sewage. The high dependence of communities towards wetlands and the exposure to water makes the users' interaction with wetlands troublesome in terms of health outcomes, given that wetlands are known sources of disease-causing microorganisms and invertebrates. Thus, wetlands are not only a blessing, but may also be a curse (Anthonj et al., 2016; Derne et al., 2015 Derne et al., 2015).

As long as these ecosystems are sustainably used, the health benefits might outweigh the health threats. The extent to which the good outweighs the bad commonly depends on site-specific factors including exactly how people interact with wetlands and how wetlands are managed (McCartney and Rebelo, 2015). Where pressure on and multiple extensive use of water resources involve the degradation of water quality and quantity (Berthe and Kone, 2008; Finlayson and Horwitz, 2015; Horwitz, and Weinstein, 2015c; MEA, 2005a, 2005b; Mulatu et al., 2015; Skov, 2015, Rebelo et al., 2010), water-related infectious disease contraction in wetlands may not be underestimated as a public health threat (Dale and Connelly, 2012; Derne et al., 2015; Patz and Confalonieri, 2005).

According to Johnson and Paull (2011), freshwater environments play multiple roles in disease relationships, starting from water acting as the transmission medium for waterborne pathogens to water providing the habitat for vectors transmitting diseases. Such ecosystems are central points for the interaction between terrestrial and aquatic species and organisms and pathogens. Human exposure to pathogens in wetland settings can be categorized according to exposure through the service provided, e.g. drinking contaminated wetland water, and, where services are eroded, the conditions giving rise to exposure, e.g. mosquito habitats favoured by modification of the wetland (Horwitz and Roiko, 2015), as well as the variable risks arising according to the season (Hongo and Masikini, 2003; Horwitz and Finlayson, 2011).

One can easily hypothesize that humans using wetlands for different purposes might be at different risk of contracting diseases. However, the available literature on wetlands' comprehensive ramifications on human health and their interactions with infectious disease transmission is not very broad (Neogi et al., 2014), case studies are lacking (Finlayson et al., 2015; Horwitz et al., 2012) and little is known about disease prevalence in wetlands (Dale and Knight 2008). In addition, knowledge gaps remain about whether and how different kinds of wetland usage may influence the exposure to and transmission of diseases.

In the following, out of each category of water-related infectious disease transmission as classified by Bradley (1974), including water-related insect vector, water-based, waterborne and water-washed transmission, the diseases of special relevance in wetlands and for wetland users in Sub-Saharan Africa are presented, namely malaria, schistosomiasis, onchocercasis, diarrhoeal diseases, typhoid fever, and trachoma. Then, they are associated with different types of wetland use. Besides identifying the main diseases addressed in the context of wetland use, this comprehensive overview on available research in the field is intended to give a literature-based evaluation on risk factors related to these uses. Overall, the review aims at representing all associations in a simplified framework, thus filling the knowledge gap on use-related diseases in Sub-Saharan Africa.

2. Data sources and methods

2.1. Search strategy and inclusion criteria

A descriptive literature review aimed at identifying articles from peer-reviewed journals and book chapters that (i) address water-related infectious diseases in SSA wetlands and (ii) link those diseases to use-related exposures. The Ramsar & World Health Organization (WHO) technical report on wetlands and human health (Horwitz et al., 2012) served as a starting point for approaching the topic. It presents a range of water-related diseases in wetlands and helped for pre-selecting a set of water-related infectious diseases present in SSA which were included in the review according to their transmission pathways. Electronic literature databases were deployed for computer-based searches, namely ScienceDirect, PubMed and Web of Science. Furthermore, electronic archives of relevant international organizations and research institutes were searched. The search within titles, abstracts and keywords included keyword combinations of wetlands; the major wetland uses; and water-related diseases as displayed in Table 1. The review approach was adapted from previous work (Völker and Kistemann, 2011).

The search included primarily literature published between 2000 and 2016. The titles of all articles identified were screened in order to identify potentially relevant studies for abstract review. Of those identified, only publications on natural inland wetlands were considered. Studies on selected water-related infectious diseases in wetlands and with a major focus on SSA were included. Also, studies linking wetland and ecosystem use and the selected water-related diseases were included. Studies dealing with constructed wetlands and saltwater resources and water-related diseases other than the pre-selected ones were excluded, as well as pesticide- or animal-related health risks (including through consumption) and diseases. All included documents were hand-searched for additional bibliographical references. The full decision procedure and inclusion and exclusion criteria of articles are shown in Fig. 1. This final set of eligible texts was subject

Table 1
Numbers of articles found in each of the three search engines for keyword and phrase searches.

Keyword combinations	ScienceDirect	PubMed	Web of Science
I Wetlands & Water-related Infectious Diseases			
wetland + disease	6.144	363	676
wetland + water-related disease	4.662	21	3
wetland + malaria	734	55	110
wetland + diarrhoea (or diarrhoea)	479	3	11
wetland + schistosomiasis	185	42	44
wetland + bilharzia	44	44	3
wetland + typhoid fever	92	0	0
wetland + onchocerciasis	52	0	1
wetland + river blindness	121	0	1
wetland + trachoma	19	0	0
II Wetland Use & Water-related Infectious Diseases			
wetland + use + disease	6.144	363	363
wetland + domestic water	7.305	281	742
wetland + drinking water	5.349	117	334
wetland + disease + domestic water	1.959	10	17
wetland + disease + agriculture	3.470	41	50
wetland + disease + livestock	1.554	17	25
wetland + disease + pastoralism	83	0	0
wetland + disease + fishery	1.457	4	11
wetland + disease + occupation	478	2	2
wetland + disease + building material	3.226	0	4