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Health risk perceptions and local knowledge of water-related infectious disease exposure among Kenyan wetland communities

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ABSTRACT

Background: Risk perceptions have the potential of motivating and shaping health-related behaviour, i.e. the application of protective health measures. They may reduce or accelerate the risk and exposure to diseases and are therefore valuable, particularly in environments such as wetlands that entail multiple risk factors exposing humans to disease-causing infectious agents.

Methods: We assessed the risk perceptions towards infectious disease exposure in the Kenyan Ewaso Narok Swamp and evaluated whether the perceived risks reflect the actual risk factors. Data were collected from community members (target population, experts) by different methods (cross-sectional survey, in-depth interviews).

Results: The overall level of risk perception regarding the contraction of diseases in the wetland was high. Exposure to water-related infectious diseases was understood as being driven by users' physical contact to water during wetland use, characteristics of pathogens and vectors of disease, both in domestic and occupational environments. The risk factors mostly associated with diseases in wetlands included the limited access to basic water supply, sanitation and poor (environmental) hygiene (WaSH) (typhoid fever, diarrhoeal diseases, schistosomiasis), agricultural irrigation (malaria), the pastoralists' proximity to livestock (trachoma), the use of agrochemicals (skin and eye diseases), seasonal flooding (malaria, typhoid fever) and droughts (trachoma). Different user groups, i.e. farmers and nomadic pastoralists, perceived the use-related risks differently and different (occupational) risks were attributed to different groups. The understanding of disease exposure as due to the intense hydro-social interactions and change present in the fragile semiarid wetland was clear.

Conclusions: By showing that the risk perceptions reflect the actual risks and shortcomings, this study underpins the vital role of wetland users as key informants. It demonstrates that risk perception studies and resulting recommendations from the grassroots level serve as helpful supportive tools for health-promoting wetland management which requires a sensitive, integrative approach that takes into consideration any and all of the humans, ecology, and animals affected (= One Health).

1. Introduction

In a world that is experiencing increased water scarcity, wetlands are becoming ever more important as settlement areas, subject to increasing and intensified use of water resources for drinking and domestic use, agricultural activities, and pastoralism in otherwise uninhabitable landscapes (Costanza et al., 1997; Finlayson et al., 2015; Horwitz et al., 2012; McCartney and Rebelo, 2015; Sakané et al., 2011). Anthropogenic alterations, as well as human and livestock pollution, however, create conditions in which water-related infectious diseases spread, with exposure depending on the wetland use and human behaviour (Appleton, 1983; Derne et al., 2015).

Use-related disease exposure in Sub-Saharan African wetlands has been reported to be associated with agricultural irrigation that potentially exposes the wetland farmers to malaria, diarrhoeal diseases and schistosomiasis. Moreover, the domestic use of water extracted from wetlands, e.g. for drinking, has been identified as being potentially harmful to human health as a source of typhoid fever and diarrhoeal diseases. Infectious diseases, frequently associated with wetland use include diarrhoeal diseases and typhoid fever (faecal-oral route), malaria (mosquitoes as disease vectors) and schistosomiasis (trematode-hosting snails as disease vectors) (Anthonj et al., 2017).

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A health risk assessment from the Kenyan Ewaso Narok Swamp (Anthonj et al., 2018a) showed that the same risk factors as previously described in the literature, including unimproved water supply and storage, inadequate sanitation and poor personal and environmental hygiene (WaSH), as well as irrigation activities, were clearly associated with the contraction of diseases characterised by abdominal complaints (e.g. diarrhoeal diseases) and fever (e.g. malaria).

Risk perceptions are of high importance to human health, as they have the potential to motivate and shape health-related behaviour, thereby reducing or accelerating the risk and exposure, e.g. through the application of (or failure to apply) protective health measures (Anthonj et al., 2018b).

Risk perceptions refer to people's intuitive evaluations of hazards they are or might be exposed to (Rohrmann, 2008), including a multitude of undesirable effects that people associate with a specific cause (Rohrmann and Renn, 2000). Risk perceptions are interpretations of the world, the evaluation of which is influenced by numerous individual and societal factors. These go beyond the classic hazard attributes and are based on experiences, beliefs, attitudes, judgements and feelings, as well as wider social, cultural and institutional processes (Pidgeon, 1998). Although risk perceptions act as triggers for precautionary action (Wiedemann and Schütz, 2005), the engagement in preventive health behaviours is not merely determined by the awareness of objective health risks, but also influenced by health beliefs and specific health cognitions (Anthonj et al., 2018b; Renner et al., 2008).

Against this background we investigated health-related knowledge regarding prevalent water-related infectious diseases and risk perceptions, as well as recommendations on how to reduce health risks among wetland communities. Such research is vital. The pivotal role of health risk perception for health-related behaviour change and risk management is widely acknowledged, but the extent to which wetland users are aware of use-related risks has not been studied. Such grassroots knowledge and experience, however, should be considered and used for health-based wetland management.

Whether the actual risks are perceived as such by the wetland communities in the Ewaso Narok Swamp, i.e. whether they associate their forms of wetland use with health risks and specific diseases, is addressed in this study.

2. Materials and methods

2.1. The study area: the Ewaso Narok Swamp

The study was conducted in the Ewaso Narok Swamp Leemhuis et al., 2016, a rural floodplain in the Laikipia county of Kenya (Fig. 1, Beuel et al., 2016; Leemhuis et al., 2016). Located nearby the town and administrative centre Rumuruti, the swamp is fed by the Aberdare Mountains and receives seasonal floodwater from the Eng'are Narok and Mutara rivers. The area is semiarid, characterised by low erratic rainfall, two distinct rainy seasons and episodic rivers.

The wetland is crucial for the livelihoods of its people (Boy, 2011). As an important source of freshwater, it forms a point of concentrated anthropogenic activities and immense ecological and socioeconomic importance to an increasing population, presenting a model case of semiarid African wetlands.

The inhabitants of the Ewaso Narok Swamp are faced with numerous prevalent diseases. Data obtained from the area's District Hospital indicate that malaria, gastrointestinal diseases, typhoid fever and diarrhoeal diseases are the main reasons for medical consultation. Skin and eye conditions have also been important reasons for such consultation, albeit for a lower number of people (Fig. 2). According to these official records, admission rates of all diseases slightly differ according to the season, with malaria peaking by the end of the rainy season as of May, and typhoid fever peaking in March at the beginning of the rainy season.

2.2. Data collection

In order to (i) capture the health-related knowledge regarding prevalent water-related infectious diseases, to (ii) investigate the risk perceptions among community members in the Ewaso Narok Swamp, and to (iii) propose strategies for an improved health-based wetland management, a mixed-method approach was adopted. Therefore, quantitative data collection was combined with qualitative methods.

Data were collected from community members (target population, experts) and with different methods (cross-sectional survey, in-depth interviews).

The cross-sectional survey was conducted among 400 household heads including smallholder (n = 106) and commercial farmers (n = 95), nomadic pastoralists (n = 99) and service sector workers (n = 100) in the Ewaso Narok Swamp. The smallholder farmers (sh) mostly use Ewaso Narok Swamp for subsistence crop production of beans and maize at the fringe of the swamp near their houses. The commercial farmers (co) grow horticultural crops such as tomatoes, cabbage and fruits for large-scale sale while living to a certain extent in temporary settlements in the wetland. The pastoralists (pa) used the wetland for herding cattle, goats and camels. People who work in the service sector (se) as sellers, tradespeople, mechanics and motor-bike taxi operators live in the nearby town of Gatundia.

The level of knowledge and risk perception of malaria, diarrhoeal diseases, typhoid fever, schistosomiasis, eye diseases, trachoma, skin and other diseases was assessed while conducting the survey questionnaire. These diseases represent the four categories of water-related infectious disease transmission as classified by Bradley (1974), and all are of special relevance in wetlands and for wetland users in Kenya (Anthonj et al., 2017). The survey was administered orally in English, Kiswahili or one of the most prominent languages among the respondents (Kikuyu, Massaii, Samburu, and Turkana) by a research team consisting of the principal investigator and five research assistants from Kenyatta University who were carefully trained in the study procedures. As part of their training, the research assistants tested the data collection tools and procedures and made adjustments according to the special requirements in the field before the onset of the study. A significant part of the training was dedicated to the (re-)translation of health-related concepts beyond biomedical terminology in the multi-cultural Ewaso Narok Swamp. In order to capture risk perceptions in differing cultural contexts, the research assistants were selected not only based on their background in public health, but also on their differing ethnic affiliations.

Key informants for open-ended, in-depth interviews were systematically identified from the household survey study participants to capture in-depth knowledge and well-grounded information about individual perceptions, experiences, and high-risk groups, setting-specific particularities and health risk behavioural patterns in the Ewaso Narok Swamp. Each of the four wetland user groups was represented with five interviewees (n = 20 in total). Moreover, experts (n = 8) working in the field of water, sanitation, health, wetland or environmental management were part of the study. Interviewees consisted of the District Health Officer (DHO), a former Public Health Officer (PHO), a community health worker (CHW), a chemist, a herbalist, a Water Resources Management Authority (WRMA) representative, a Rumuruti Water and Sanitation representative, and a Primary School representative. They served as a supplementary source of information for the formulation of recommendations. Compared to the in-depth interviews with the target population, those with experts were more distinct for each of the different interviewees, more focused and less explorative. All informants and experts acted as providers of context knowledge (Bowling, 2014).

All interviews were conducted after obtaining an informed consent from each participant both for the data collection during the survey and for the in-depth interviews. Ethical clearance was obtained from the Ethics Review Committee of Kenyatta University (KU/R/COMM/51/411) and the Ethics Committee of Bonn University Hospital (246/14).

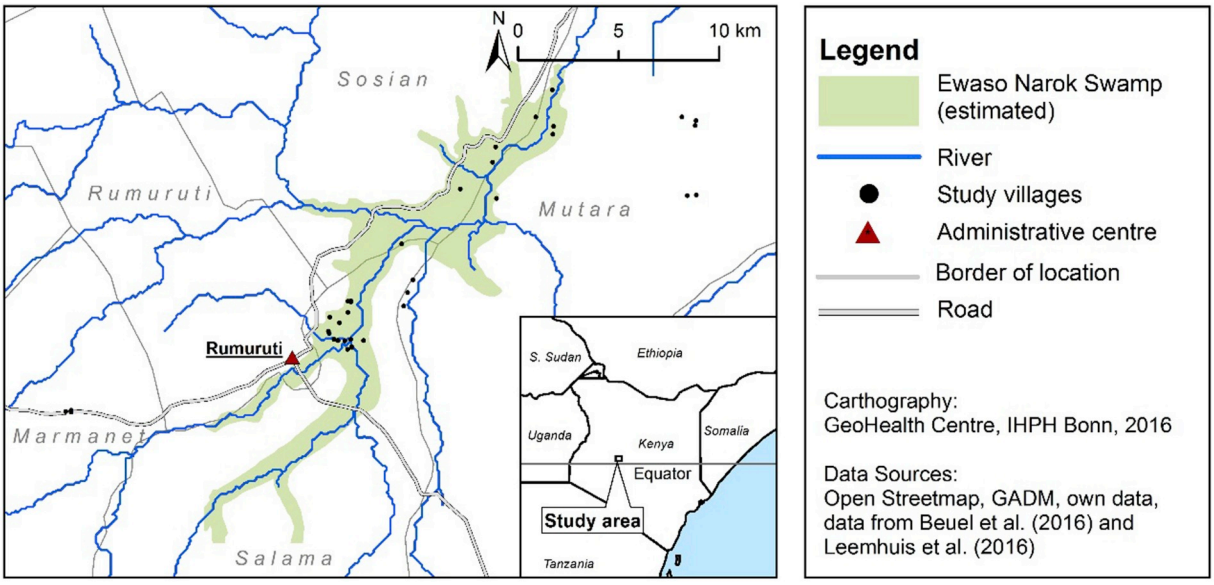


Fig. 1. Study area around the Ewaso Narok Swamp, Laikipia, Kenya.

2.3. Data analysis

The quantitative empirical data was analysed and stratified by user groups and diseases in order to illustrate and underline certain risk perceptions, differences and gaps in terms of health-related knowledge on diseases, transmission pathways and associated risk factors in wetlands. The quantitative data was complemented by and triangulated with qualitative perceptions and experiences by the target population and by experts. The audio-recorded qualitative data from the semi-structured interviews was transcribed by use of the software easytranscript®. The data was then analysed using ATLAS. ti7® software. The data categorization was based on main themes in the qualitative results that were addressed by the interviewees, including overall risk perception, knowledge on and seasonality of diseases, and use-related and occupational risk factors.

3. Results

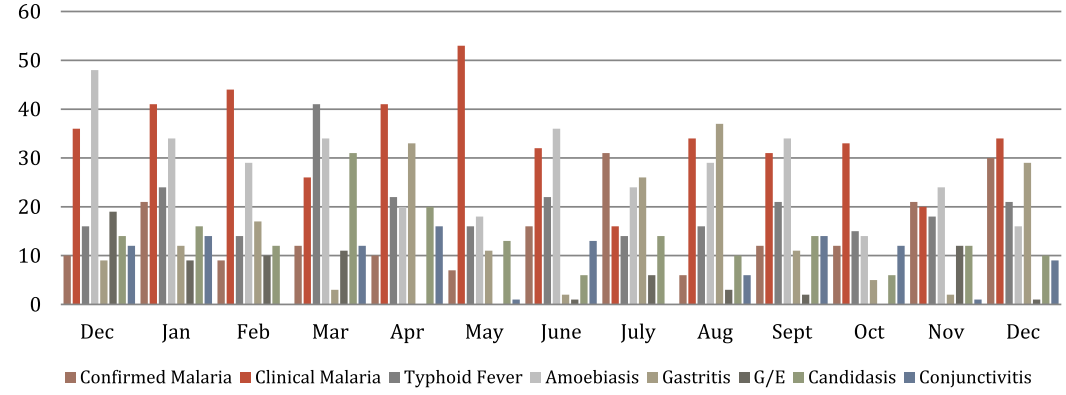
3.1. Local health risk perceptions

Out of all community members interviewed in the Ewaso Narok Swamp, 61% perceived people in wetlands to be exposed to higher health risks compared to people outside of wetland (25% disagreed, 14% did not know). In the following open-ended questions, numerous febrile, respiratory, abdominal, eye, skin, joint and other conditions and symptoms were linked to the Ewaso Narok Swamp and its use and to certain risk factors. The disease mostly named by respondents was malaria (n = 204), followed by typhoid fever (n = 182), several diarrhoeal diseases, pneumonia, flu, joint conditions, and several eye and skin diseases, as well as other conditions. Risk factors attributed to diseases in wetlands covered poor wetland water quality of surface wetland water (n = 170) as causing waterborne diseases, particularly when drinking and using the water for domestic purposes (Fig. 3). The subsequent in-depth interview statements reflect this awareness:

> *'If you stay near a wetland, you can get more diseases. The water from the river passes many places and collects a lot of dust. People living nearby, they use it as the only source of water and that causes typhoid fever, diarrhoea and cholera.'* (se4)

> *'Diseases are mostly caused because the water is dirty. Then the people step in the water, they bath in the same water and also animals use the same water.'* (pa2)

The water was described as being contaminated, thus affecting the health of humans and livestock. The swamp was perceived as providing large mosquito habitats (n = 67), exposing the people to a high risk of



*The acronym G/E stands for gastroenteritis.

Fig. 2. Rumuruti district hospital admission from December 2013–December 2014. Data obtained directly from the hospital by manually copying the numbers from hospital admission books.

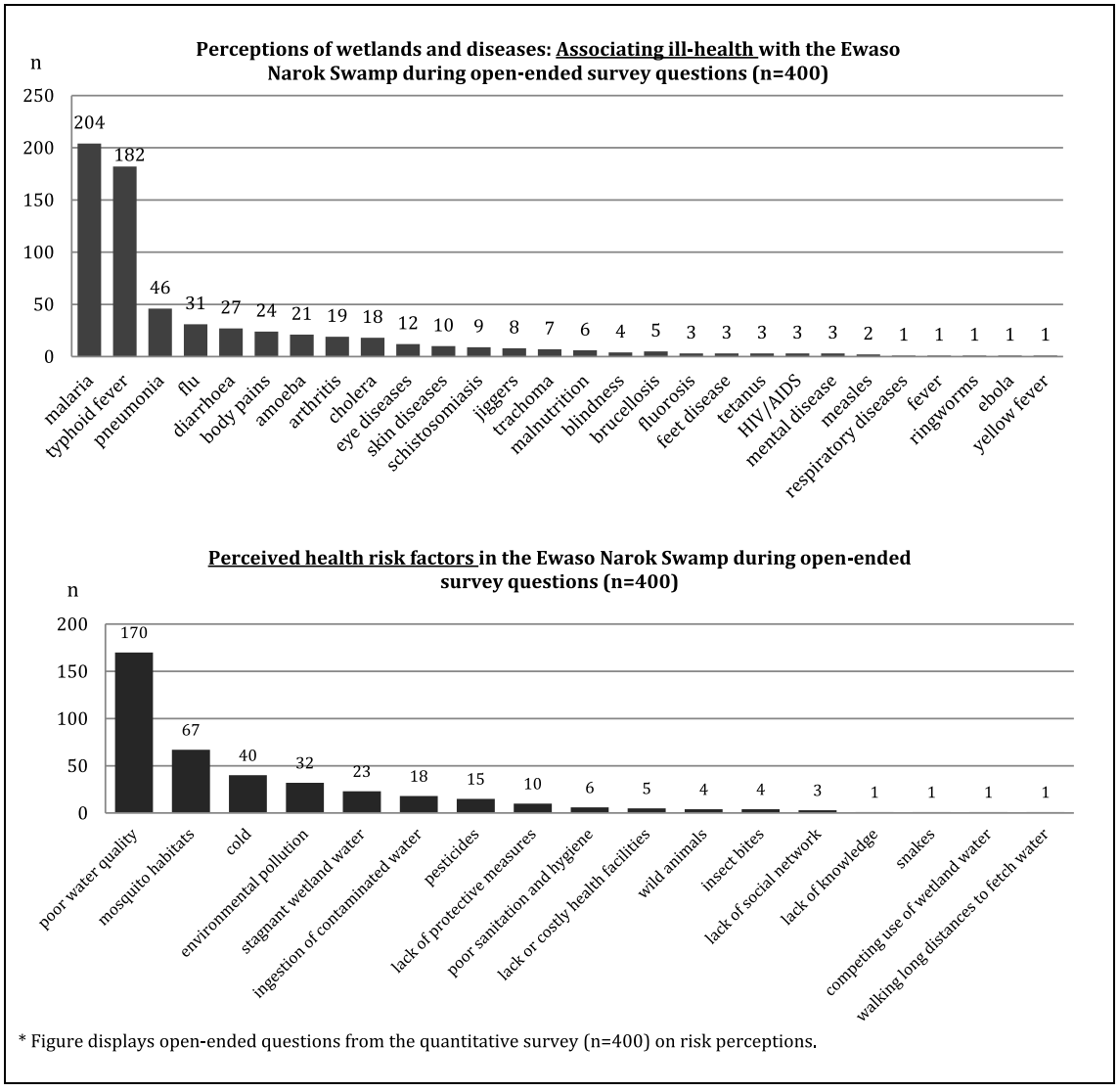


Fig. 3. Perceptions on diseases & risk factors in the Ewaso Narok Swamp.

contracting vector-related diseases.

'The biggest health challenge in the Ewaso Narok Swamp is malaria, because there is so much stagnant water and so many mosquitoes.' (sh4)

The colder temperatures compared to the surrounding areas (n = 40) were linked to respiratory and cold-related conditions (pneumonia, flu, other respiratory illnesses), as well as physical conditions.

'Coldness is the problem and wetness at the same time. It gives the people pneumonia, upper respiratory tract infections, on and off. Especially in children.' (se2)

Environmental pollution (n = 32) was named as a health risk factor by several respondents, and so were the use of pesticides and poor sanitation and hygiene (n = 6), all linked with water-related infectious diseases (water-borne, -based and -washed diseases, e.g. eye and skin diseases, trachoma, schistosomiasis).

'There is water contamination. Animals contaminate the source and many users share the same water. (…) The water comes from the rain, goes to the river, and due to a lack of toilets, it is contaminated and causes typhoid fever, diarrhoea and vomiting. Skin conditions occur because of contamination, the unclean environment and the lack of toilets. The people also face eye conditions due to the dust, water and environment. It is very dirty.' (sh4)

'All the chemicals used in agriculture, they are entering the eyes and cause eye conditions and even blindness. But the people think that chemicals don´t affect their health.' (se4)

Other risk factors covered behavioural and infrastructural issues, such as the lack of preventive health measures, lack or cost of health facilities, or the lack of knowledge on how to handle risks and diseases. In addition, the competing use among wetland users and long distances to the water supply were addressed.

3.2. Perceptions of seasonality of disease

The majority of all respondents (88%) rated health risks and diseases in the wetland as seasonally-dependent. The open-ended specification gave deeper insight, revealing that the burden of disease was perceived to be higher during the rainy season (n = 139). When the respondents were asked to specify the implications (Fig. 4), 160 of them mentioned an increased risk of contracting malaria. However, the rainy season was not the sole season perceived to entail risks:

'There are different diseases for different seasons. In the rainy season, there is more malaria and more people have colds and pneumonia due to the cold and lack of good bedding. In the dry season, air-borne diseases

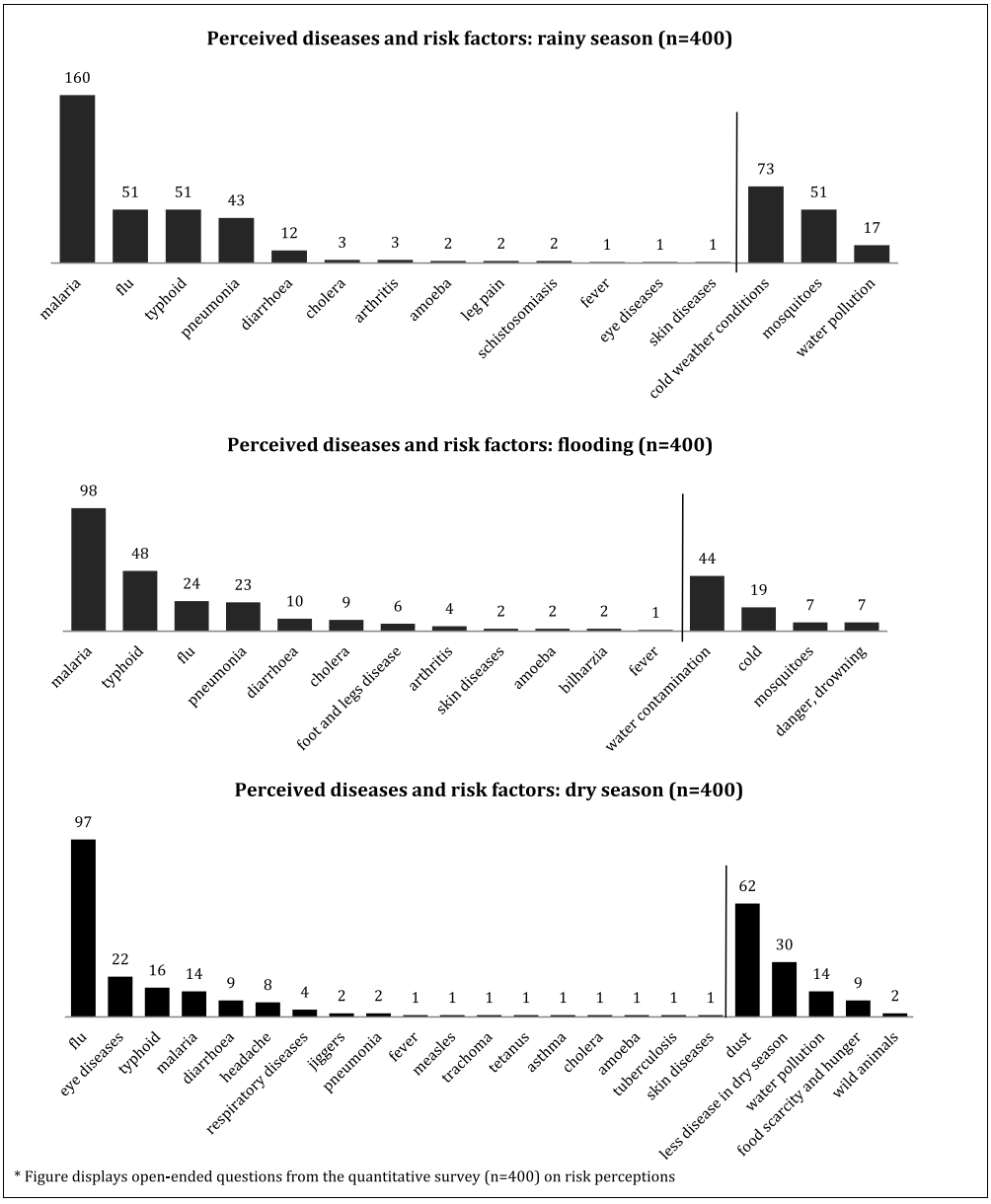


Fig. 4. Perceptions on seasonal diseases and risk factors in the Ewaso Narok Swamp.

are common and cough, dehydration and malnutrition.' (se5)

Nonetheless, during the rainy season, the water was perceived as being more polluted, posing the risk of increased waterborne diseases such as typhoid fever, diarrhoeal diseases and cholera.

'In the rainy season, there is a lot of water. The floods carry dust and dirt. But still, the people use that water for drinking, for cleaning, washing. This causes typhoid fever.' (se4)

The water pollution and resulting health challenges were associated with the lack of proper means of sanitation and the sharing of water resources by many users. An increased disease burden of schistosomiasis, eye and skin diseases were also linked to the rainy season. Flooding was perceived as posing a higher burden of disease to the inhabitants in the Ewaso Narok Swamp by 81% of the respondents.

'Here when it rains, there is so much flood but it flows, you know the landscape. It brings more diseases like malaria.' (se1)

'There is more typhoid fever, because people help themselves in the bushes. When there is flooding, that river collects dirt and carries it to all the places.' (se1)

The dry season was perceived by 49% of the respondents as increasing the burden of disease. The respondents mostly associated the dry season with flu, respiratory conditions and eye diseases. Dust was used as a synonym for dirty environment.

'Eye diseases occur when it is dry and depend on weather conditions and drought.' (pa4)

Challenges that were emphasized included the reduced water levels in the dry season, deteriorating the water quality and entailing the risk of contracting waterborne diseases such as typhoid fever and diarrhoeal diseases, particularly in children.

'I think that the dry season really causes a lot of problems, because (…) *of the reduced water level.* (…) *The water is contaminated and this causes typhoid'.* (co5)

An increased burden of malaria was perceived by several respondents. One serious health threat perceived by the people in the Ewaso Narok Swamp was the food insecurity and hunger resulting from

water scarcity. The dry season was described as leaving people with poor harvests and poor diet, especially for children.

'In the dry season, not getting enough food is a problem. Health depends with your nutrition, diet and fluids.' (sh3)

Another aspect, which was not raised in the open questions following the survey, but which was underlined in the in-depth interviews, was the loss of livestock in the dry season or due to drought. This was much highlighted by the pastoralists interviewed:

'Drought is a real challenge to the people, when there is no food, and the animals lack water and they die.' (pa5)

'When it is really dry like now and you lose all your cattle, it causes a lot of stress.' (pa3)

3.3. Local knowledge on water-related infectious diseases

The disease mostly associated with the use of the wetland was typhoid fever (74%), closely followed by malaria (70%). Moreover, more than half of those with knowledge of the diseases linked pneumonia (61%) and flu (53%) to wetland use. Less than half of the respondents perceived wetland-related exposure as linked to diarrhoea (48%), schistosomiasis (42%), cholera and skin diseases (34% each). Only 24% of those surveyed related trachoma and other eye diseases to wetland use.

A certain group-specific pattern appeared concerning the perceived wetland use-related exposure (Fig. 5): pastoralists and smallholder farmers linked wetland use to most diseases, whereas the service sector workers associated it the least.

The in-depth interviews gave deeper insights into the links between the wetland-related exposure, transmission pathways, and risk factors of malaria, diarrhoeal diseases, typhoid fever, schistosomiasis, eye and skin diseases.

The common sense was that wetlands were intrinsically connected with a high occurrence of mosquitoes, responsible for a perceived high prevalence of malaria.

'If you use to stay in the wetland you are affected by water and mbu [mosquitos] causing *malaria.'* (sh3)

'Those wetlands that harbour mosquitos are not good for health, so the people will be prone to malaria.' (se2)

Diarrhoeal diseases were especially associated with unsafe wetland water, with pollution, contamination and low water quality:

'Well (…) *sometimes you find that contaminated water brings about some abdominal problems like diarrhoeas, or you get mostly abdominal problems.'* (co1)

'People have amoeba due to contaminated water and their diet. It is common here because we use the water straight from the river.' (sh2)

Moreover, the lack, inadequacy, and impact of sanitation itself as a cause for water contamination, especially during rains and flooding, were described as causes for diarrhoeal conditions. In particular, the ethnic groups of nomadic pastoralists were considered susceptible:

'Diarrhoeal conditions, they are so common. Because most of the people here, like these marginalized groups like the Turkana, the Nandi, most of them do not have toilets in their homestead. So they normally use the bushes. When it rains, it collects a lot of waste, a lot of faeces and then the people collect and drink this water … ' (se2)

Typhoid fever was closely associated with the wetland water used for multiple purposes and by many different users, contaminated by people, livestock, agriculture and domestic waste, and inadequate sanitation:

'Typhoid, so you get it from dirty water. The water in the swamp is dirty sometimes, because people will go and wash their clothing there, they misuse it, they will not use it properly. Because you are supposed to fetch that water and take it a bit far from the river so that when it goes back to the river it will be safe. When people use it, it will be contaminated.' (se1)

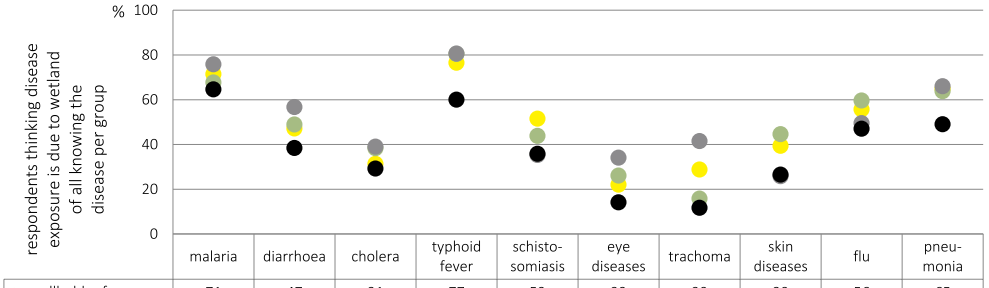
Despite the knowledge about typhoid fever's transmission pathways and about preventative measures, these were often not applied as the disease was not taken too seriously.

'The water is dirty and is consumed like that. The same bacteria are being washed to the river so we will have the typhii bacteria for the typhoid, and we later get that untreated water, we consume it.' (se2)

Schistosomiasis was closely linked to wetlands. The respondents knew that the presence of schistosomiasis-hosting snails was dependent upon stagnant water, physical skin contact and the proximity to dams:

'Wetlands harbour snails, when you go there and work, you get bilharzia because the snails harbour larvae. (…) *The larva will find a host where they will thrive and then they will go in the water, then they will get into your body through the skin.'* (se1)

'Bilharzia is brought about by water flukes and the stagnant water.' (co1)



	malaria	diarrhoea	cholera	typhoid fever	schisto-somiasis	eye diseases	trachoma	skin diseases	flu	pneu-monia
smallholder farmers	71	47	31	77	52	22	29	39	56	65
commercial farmers	68	49	38	80	44	26	16	45	60	64
pastoralists	76	57	39	81	35	34	42	26	50	66
service sector workers	65	38	29	60	36	14	12	27	47	49

* Figure displays information from quantitative survey (n=400), reflecting wetland users' risk perceptions on water-related infectious disease exposure based on the classification of Bradley (1974) and selected wetland-related diseases (Anthonj et al. 2017).

Fig. 5. Exposure to wetland-related infectious diseases and other diseases associated with wetlands as stated by user groups in the Ewaso Narok Swamp [%].

Awareness existed on the transmission of schistosomiasis via the faecal-oral route, as well:

'The excreta and also the urine can contaminate more people. The whole community can get it when one person is affected.' (se1)

Wetland water, environmental contamination, poor personal hygiene, insects and flies were deemed responsible for the contraction of trachoma and other eye diseases.

'People lack hygiene and this can cause conjunctivitis of the eyes, and trachoma. I think it's this persistent being attacked by flies due to the poor hygiene.' (se2)

'Trachoma is transmitted from one to another. To prevent it, you need to be clean.' (sh3)

As a consequence of their close interaction with livestock in their homesteads, certain marginalized pastoral groups were seen as especially prone to eye diseases:

'Eye diseases are affecting mostly the Samburus and Turkanas [pastoral groups]. *Because they interact a lot with cows and flies are attracted to milk.*' (co3)

Contact with contaminated water, as well as poor personal hygiene, especially during the rainy season were the main risk factors the interviewees named for skin diseases,

'Even the daily use of water causes skin diseases. Because when it rains the water carries a lot of dirt and sewer contamination from the higher grounds to the lower grounds. That is drained into the rivers and that is the water that we fetch to use.' (sh2)

As reported by several respondents, two main transmission pathways were known: the transmission by insects and worms inhabiting the water and the contact to mineral fertilizers and synthetic pesticides during irrigation or cattle spraying activities:

'Skin diseases can also be due to worms, you scratch yourself, you have roundworms in your body and there they form nodules.' (sh3)

'When I am irrigating, if I get contact with a lot of water, the skin gets irritation. This comes from the soil, the chemicals, fertilizers and pesticides.' (co1)

'As for the pastoralists, when we go to spray or take our cattle to the dip, if we don't wash our hands well, the chemicals get to our eyes and cause diseases and skin rashes.' (pa3)

3.4. Associating use-related risk factors to wetland-related diseases

The quantitative findings reveal that wetland users perceive different diseases as associated with different risk factors to variable extents (Fig. 6). WaSH factors were understood as especially responsible risk factors for malaria, diarrhoeal diseases, and eye and skin diseases. Further, mosquito breeding sites, the use of pesticides in agricultural crop production and seasonal features, as well as a lack of health services were linked with diseases in the Ewaso Narok Swamp.

The stratification of the result by user groups shows similar trends for all diseases (Fig. 7): no matter the risk factor, the service sector workers are the group that mostly associates the risk factors with diseases throughout all categories, followed by the commercial farmers. Overall, the group of pastoralists seems to have the lowest risk perception or awareness of risk factors to diseases in the Ewaso Narok Swamp.

3.5. Perceptions of use-related occupational health risks

The in-depth interviews revealed that farmers and pastoralists were perceived to be exposed to different health risks (Table 1): farmers' occupational proximity to water exposes them to risks of contracting malaria, waterborne diseases and cold and flu. The pastoralists' challenges were water access and distance to the water source, water scarcity, open defecation, and proximity to livestock and resulting poor hygiene. These factors are linked to skin and eye diseases.

A much emphasized health threat was the use of agrochemicals in the Ewaso Narok Swamp. With increasing use of mineral fertilizers and pesticides such as fungicides, herbicides and insecticides/acaricides, the burden of diseases in the swamp was described as having increased. Health risks would cover both water-washed and airborne contact with chemical substances, leading to skin irritations, eye conditions, headaches, dizziness and respiratory problems. Although these risks are perceived as higher for farmers, pastoralists also found themselves facing similar risks when applying chemicals like acaricides or veterinary drugs to livestock in order to control for vectors and diseases. The contamination of water sources that resulted from the use of chemicals was rated as a significant contribution to the burden of diseases, for which the users considered themselves responsible.

4. Discussion

4.1. Health risk perceptions on water-related disease exposure

The people in the Ewaso Narok Swamp perceived exposure to water-related infectious agents as dependent upon the type of use, domestic and occupational characteristics, and understood disease transmission as driven by users' physical contact to water during wetland use, characteristics of pathogens and vectors of the diseases. The overall level of risk perception regarding the contraction of diseases in the wetland was high. The risk factors that were mostly associated with diseases in wetlands were the use of unsafe water sources for drinking and domestic purposes, inadequate sanitation, and poor personal and environmental hygiene. Poor WaSH was perceived as causing exposure to waterborne diseases (mainly diarrhoeal diseases and typhoid fever), vector-related diseases (malaria), as well as water-washed (eye and skin diseases, trachoma, agrochemical-related problems) and water-based diseases (schistosomiasis).

These findings highly correspond to an actual health risk assessment which analysed risk factors associated with self-reported abdominal complaints and fever related to the use of the Ewaso Narok Swamp among the same community members (Anthonj et al., 2018a). In other wetland contexts in Sub-Saharan Africa, the use of wetland water, the limited sanitation infrastructure and poor hygiene have been previously linked to numerous water-borne, water-based (e.g. Derne et al., 2015; Fuhrimann et al., 2015), water-washed (Berthe and Kone, 2008) and vector-related diseases (Prothero, 2000). However, the scientific literature thus far has concentrated rather on health risks associated with occupational, crop production-related risk factors such as irrigation canals favouring disease exposure mostly in wetlands (Anthonj et al., 2017), and diseases such as malaria and schistosomiasis (e.g. Appleton and Madsen, 2012; Resh, 2010).

In the literature, diseases that the people in the Ewaso Narok Swamp perceived as being exposed to due to their use of the wetland, such as typhoid fever, were so far addressed only in a very limited way, as was the risk of trachoma.

The evaluation of wetland users' risk perceptions shows that the subjective understanding of disease risks in the wetland community strongly reflects the theoretical framework on wetland-use-related risk factors (Anthonj et al., 2017) and the inadequate provision of water, sanitation and hygiene infrastructure found in the study area (Anthonj et al., 2016).

Moreover, comparing the users' perceptions of disease risks (Figs. 3 and 4) with the District Hospital's admission rates (Fig. 2) indicates that those diseases perceived as particularly prevalent – malaria, typhoid fever and diarrhoeal diseases - are the ones that make the community seek care. The perceived seasonality of diseases is reflected in the

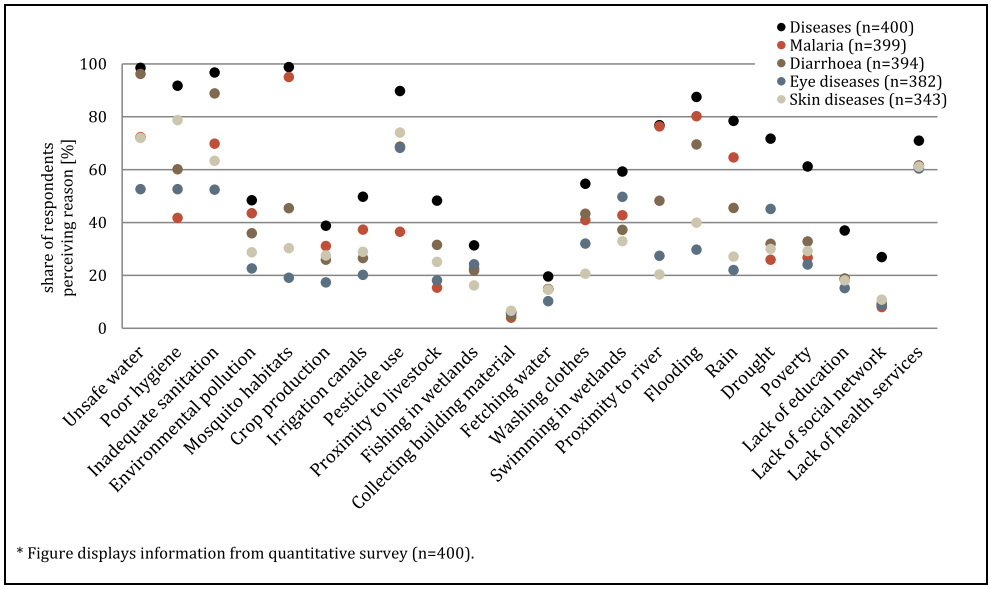


Fig. 6. Associating reasons and risk factors with diseases in the Ewaso Narok Swamp [%].

official records, as well.

4.2. Local knowledge on water-related infectious diseases

The users were well aware that wetlands provide optimal conditions and breeding sites for mosquitoes that vector and transmit malaria. They were aware of the risk being greater in proximity to stagnant water and irrigation canals. They knew that environmental pollution may increase the risk, and that according to the season, the risk of malaria may differ. Not only the occupational, but in particular the domestic domain (e.g. unsafe water storage in open containers) was perceived to matter in terms of malaria risk. The users' perceptions reflect the actual risk as evidenced in a health risk assessment from the Ewaso Narok Swamp (Anthonj et al., 2018a).

Diarrhoeal diseases were perceived as associated with several risk factors in the study area, including the ingestion of unsafe surface water, poor personal hygiene and inadequate sanitation, as well as poor waste management, wastewater irrigation and environmental pollution, all of which has been evidenced previously (Anthonj et al. 2017, 2018a; Tumwine et al., 2002).

The ingestion of contaminated water as well as environmental pollution, both amplified during periods of flooding, agricultural activities in wetlands, as well as the use of manure and the proximity to livestock or their waste were aspects linked to typhoid fever during the in-depth interviews. All have been demonstrated earlier as important risk factors to the disease (Anthonj et al., 2017; Fuhrimann et al., 2015; Neogi et al., 2014).

Skin diseases were perceived as a major challenge in the Ewaso Narok Swamp, due to poor hygiene and caused by environmental pollution. Some respondents also attributed skin diseases to contact with parasites that infest the wetland water. Skin diseases were largely described as linked to occupational wetland use, to commercial farming, to use of agrochemicals, as well as to irrigation activities. These perceptions reflect the actual health risks in the research area and in wetlands (Anthonj et al., 2017; Fuhrimann et al., 2015).

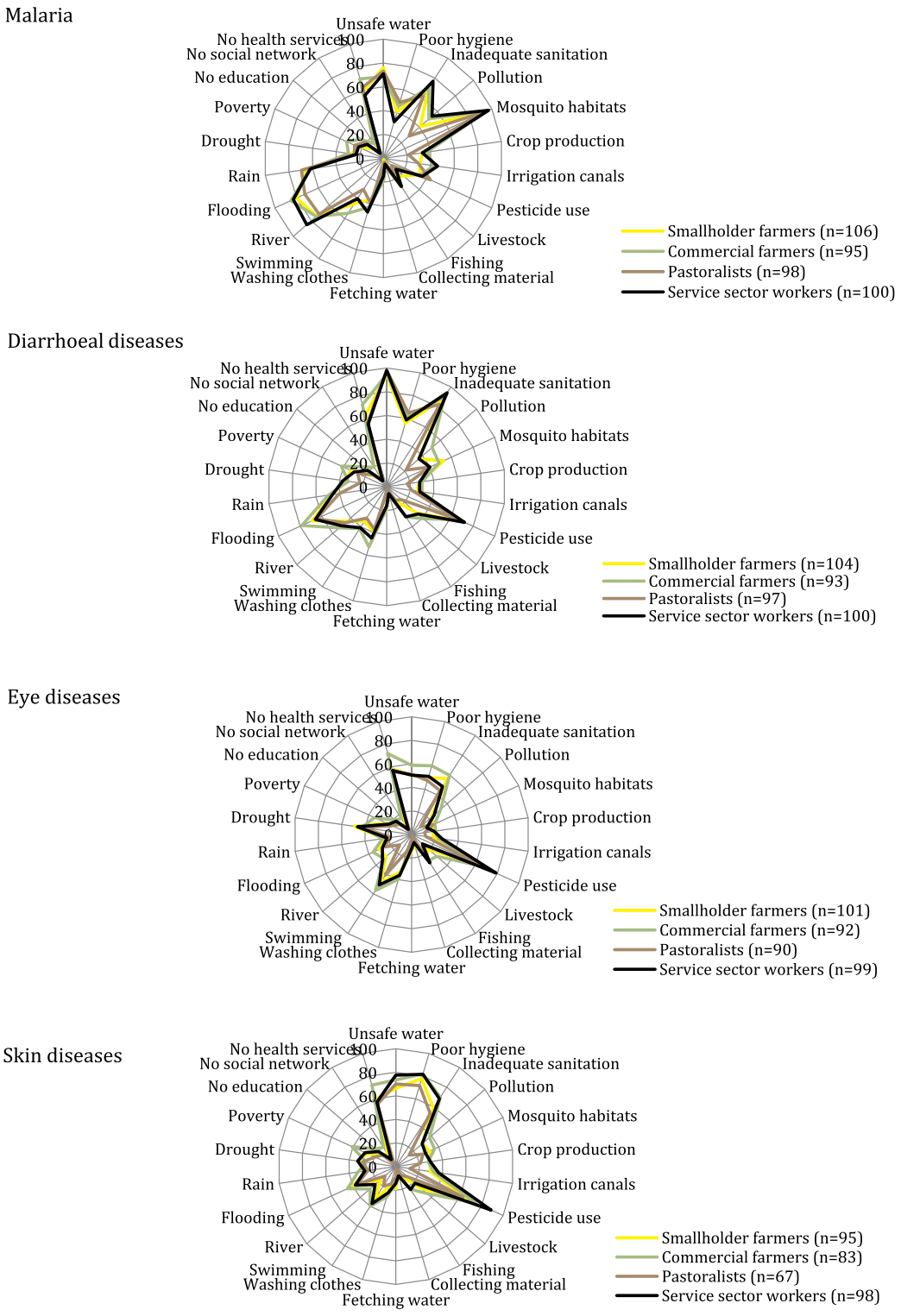
Trachoma, a neglected tropical disease (NTD) commonly associated with water scarcity, remoteness and poor WaSH (Berthe and Kone, 2008), was also perceived to be associated with the use of wetlands, with factors increasing the risk being distance to a water source, environmental pollution, the presence of flies, large household sizes and low socioeconomic status. All of these factors have been previously evidenced (Anthonj et al., 2017; Overbo et al., 2016). In the Ewaso Narok Swamp, the pastoralists were believed to be susceptible to eye diseases or trachoma, considering their unsafe WaSH situation (Anthonj et al., 2016), with this perception mirroring reality (Anthonj et al., 2018a; Hotez and Kamath, 2009).

Moreover, the community was aware of the NTD schistosomiasis, its transmission by parasites hosted by and released into stagnant water bodies by snails, and risk factors such as the proximity to wetlands and unsafe WaSH — particularly the ingestion of unsafe wetland water or the use of such for bathing and environmental pollution. Also, agricultural activities were perceived as determinants in the risk of contracting schistosomiasis, which has been evidenced before (Anthonj et al., 2017; Appleton and Madsen, 2012; Derne et al., 2015).

4.3. Different risk perceptions among different wetland user groups

The varied wetland user groups perceived the health risks arising from wetland use differently as resulted from the quantitative part of this study (Fig. 7). Compared to other groups, smallholder and commercial farmers saw the strongest links between the wetland, risks and diseases as likely due to their proximity and dependence on the wetland water source. By contrast, the pastoralists, compared to the other groups, had the strongest perceptions of linkage between an increased burden of diseases and decreased water quality, potentially due to high dependence on water for drinking (also for their livestock) and due to their long history of living in and depending upon the swamp, giving them extraordinary experience and knowledge of environmental–human dependencies. The service sector workers had the weakest perception of the risks in wetlands, likely due to their occupational features of working in small businesses in centralized areas, further away from the Ewaso Narok Swamp, neither being dependent upon the wetland for their livelihoods nor being directly exposed to this specific environment on a daily basis. Consequently, they lack experience on risks associated with the wetland.

The specific knowledge on water-related infectious diseases differed widely, as well. Most of the people were able to link typhoid fever and malaria with wetlands; NTDs such as schistosomiasis or trachoma were linked with wetlands by fewer people. However, overall, these perceived disease exposures correspond with the diseases potentially prevalent in wetlands (Appleton, 1983). The overall knowledge on diseases was highest among the service sector workers. This is also reflected in the quotes extracted from the in-depth interviews with representatives of the different user groups which were included in this study. Service



* Figure displays information from quantitative survey (n=400).

Fig. 7. Malaria, diarrhoeal, eye and skin diseases: Perceived risk factors [% of n = 400].

sector workers were the ones with most detailed knowledge on diseases (21 included quotes), followed by commercial farmers (15 included quotes), smallholder farmers (10 included quotes) and pastoralists (9 included quotes). This bias may mirror the differing levels of formal school education among the different groups, thus differing access to knowledge on disease transmission pathways (Anthonj et al., 2016).

4.4. Health effects in semi-arid wetlands

The risk perceptions of wetland users pointed to the Ewaso Narok Swamp as being a special case (Fig. 8). Wetlands form the most important source of water in semi-arid regions and are used by varied groups for different purposes, most importantly for drinking and domestic water. Farmers live in close proximity to the swamp and use the

Table 1
Qualitative themes: Perceptions of use-related and occupational risk factors.

	Farming	Pastoralism	General
water-related infectious diseases	*Farming in the wetland can harm health.* (pa5) *The biggest challenges that farmers face at their work place are malaria, amoeba, typhoid and brucella, and the cold water is also bitter for people who work long hours in the wetland. Also, flooding is a big threat for people who work here* (co3). *The farmers do irrigation of their fields. They stay always in the water and many wear no safety clothes. They easily get malaria, typhoid fever and colds.* (se5)	*With livestock farmers,* (…) *in the homestead that animal waste can bring problems because* (…) *it becomes a good environment for insects* (…) *You expect those people to be affected by eye and skin disease because they are not hygienic, they are moving long distances to get water and once they get water its meant for their animals* (se3) *Pastoralists migrate to different areas. They live under poor conditions in tents. They have a poor diet with meat and milk only. Sometimes the animals are sick and cause diseases.* (se5) *The pastoralists are more at risk than farmers.* (co3)	*There is a difference when it comes to health risks for pastoralists and for farmers. When you are a farmer, you will stick to one place so* (…) *you will not be prone to diseases because you are situated in one place. But as a pastoralist, you will move from one place to another* (…) *so when you go to a place where there is an outbreak, you will just get it. And you know the temperatures affect the pastoralists.* (se1) *The diseases are not different for farmers or pastoralists.* (pa1)
use of chemicals	*It is common to use chemicals and that gives skin problems. Even the inhaling causes diseases.* (se5) *Those who use the fertilizers have skin pimples and eye problems, and respiratory problems.* (sh5) *Using those chemicals without protective gear they get diseases, headache, and dizziness.*(pa3) *There was a time when I used some pesticide. I forgot to wash my hands* (…) *and that caused all that swelling on my face. It is very poisonous.* (co5)	*As for the pastoralists, when we go to spray or take our cattle to the dip, if we don't wash our hands well, the chemicals get to our eyes and cause diseases. It can also bring skin rashes.* (pa2)	*The pastoralists spray their animals near the water or in the water. This causes poisonous contamination of the water, it is bad for the body. Many farmers use chemicals on their fields, they cause the same health problems.* (co4) *Nowadays there are more diseases than before, because the people do irrigated agriculture and use chemicals because they do not trust manure. They get ill.* (se4)
protective measures	*They use pest control and fertilizers, but only few use a pump or protection. Instead, they apply the chemicals with their hands.* (se4) *The farmers use fertilizers, they get to your system, your chest.* (co5)	*If you compare them* [the farmers] *with these nomads, they move from here to there is a lot of temperature in the foot so you find them wearing open shoes yeah …* (se3)	*The health risks are not different but them. Some have been brought up traditionally by their forefathers to use medicinal plants. They approach health issues differently but it's not that* [risks] *would affect them differently.* (sh1)

*These selected quotes reflect information gathered during open-ended in-depth interviews (n = 20).
**The individuals interviewed belonged to four different user groups, namely smallholder farmers (sh), commercial farmers (co), pastoralists (pa), and people working in the service sector (se). Each group is represented with n = 5.

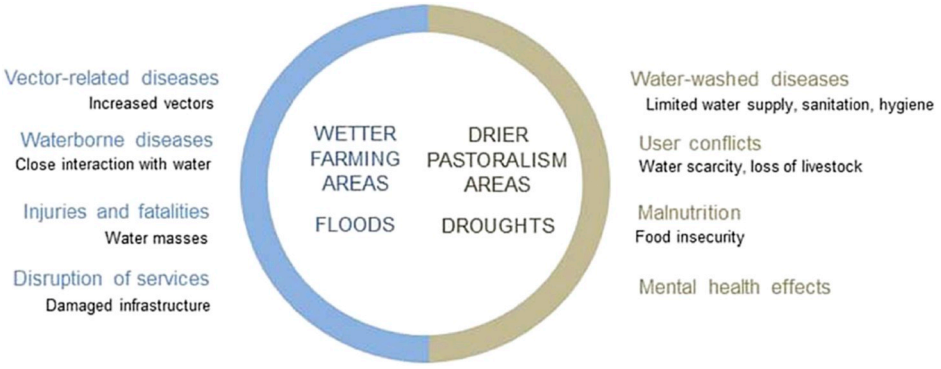


Fig. 8. Health effects in a semiarid wetland. A special case. Graph based on findings.

provided water extensively for their agricultural activities, whereas pastoralists, who live in the drier and more distant surroundings of the swamp, mainly herd their livestock to the water source.

In the wetter areas, primarily exploited by farmers, mosquito breeding sites are vastly prevalent, favouring the occurrence of disease vectors and increasing vector-related diseases such as malaria (Omukunda et al., 2012). The accumulation of wastewater, sewage, faecal matter and other disease-causing agents in the swamp contaminates the wetlands' water, leading to the spread of waterborne diseases like diarrhoeal diseases, cholera and typhoid fever. All of these adverse health effects are significantly accelerated during heavy rains and flooding (Derne et al., 2015; Githeko et al., 2000; Patz and Confalonieri, 2005), as contaminants from the surrounding areas accumulate in the low–lying swamp. Additionally, especially during flooding, the water may cause fatalities and destruction of the health sector. The potentially increased burden of disease during flooding is then simultaneously magnified in conjunction with the consequences of the natural hazard: damaged (WaSH) infrastructure, disruption and inaccessibility of healthcare putting an additional burden on the already strained health system capacities (Anthonj et al., 2015).

In the drier areas, where primarily pastoralists live and work, the most pressing health challenge is the shortage of water, mainly due to the lack of access: in the Ewaso Narok Swamp, the water sources are usually located far from the pastoralists' homesteads. This is demanding particularly for the female family members who walk long distances to acquire water from unsafe surface sources which may be contaminated. In these areas, water remains a scarce resource, both in terms of quantity and quality (Nyong and Kanaroglou, 2001). According to Bartram and Godfrey (2015), 20 L daily per person from a source within 1 km, or less than 30 min collection time from the user's dwelling, is the definition of reasonable water access. In the pastoralist areas of the Ewaso Narok, this requirement is unrealistic, making healthy and hygienic living and nutrition a challenge. The widespread water shortage leads to limited hygiene for this user group (Anthonj et al., 2016), as the limited water available needs to be shared with the livestock. Along with a lack of sanitation, this situation makes semiarid wetlands conducive environments for the spread of water-washed diseases such as trachoma. In the dry season, the seasonal streams and water points dry up, creating conflicts between the different users over the scarce water sources (Bell, 2015; Roden et al., 2016). The loss of livestock from

water scarcity results in adverse mental health effects among pastoralists, who depend upon cattle for the maintenance of their livelihoods, as addressed by Hongo and Masikini (2003).

This compilation (Fig. 8) illustrates the contrasting adverse health effects and threats of natural environments around the swamp, underpinning the complexity and peculiarity of semi-arid wetlands that host risks linked both to wet and dry conditions. It also draws attention to the vulnerability of such ecosystems and the inhabitants which depend upon them for the maintenance of their livelihoods during both rainy and dry seasons (Dale and Connelly, 2012; Mungai et al., 2004; Mwita, 2013).

4.5. Awareness of neglected tropical diseases in the wetland

The communities in the Ewaso Narok Swamp are aware of the existence and transmission pathways of two NTDs, namely schistosomiasis and trachoma. The knowledge of risk factors of trachoma is present among the high-risk group for trachoma in the wetland, namely the pastoralists, who live in rural, remote, water-scarce areas, proximate to livestock The pastoralists also are the group which mostly lacks access to basic water and sanitation services (Anthonj et al., 2016) and have unhygienic health behaviour practices (Anthonj et al., 2018a). This knowledge on NTDs in the Ewaso Narok Swamp is likely the result of community health workers' educational efforts and an awareness raising campaign which was run during a trachoma program in Rumuruti by Amref Health Africa, an African NGO, in 2012, as reported by health officials during expert interviews.

According to the World Health Organization (2015), NTDs affect over one billion people worldwide, causing chronic disability and death, primarily among the disadvantaged. Despite the critical importance of addressing such diseases, they remain widely unknown, underreported and untreated, even among many health professionals. The underreporting is also apparent in official health records as provided by the District Hospital in Rumuruti, which lack information on the occurrence of NTDs (Fig. 2).

These circumstances make the findings on the awareness on NTDs in the Ewaso Narok Swamp remarkable. The people interviewed were well aware of the means for reducing exposure to infection by these NTDs: safe water supply to prevent consumption of contaminated water, reduced contact with surface water, and personal hygiene practices; access to and use of sanitation facilities, the safe management of faecal waste to reduce human excreta in the environment; water resources, wastewater and solid waste management for vector control and contact prevention; and hygiene measures such as handwashing with soap. This is consistent with Esrey et al. (1991), who evidenced safe and sufficient water supply on the premises or near the house for personal and domestic hygiene (reduction in trachoma risk), as well as safe human excreta disposal (reduction in schistosomiasis risk) as main protective measures.

The provision of safe WaSH is not a given in the Ewaso Narok Swamp (Anthonj et al., 2016) and has so far received little attention in NTD control programmes (Grimes et al., 2014; Stocks et al., 2014). Joining NTD and WaSH management, therefore, should be prioritized in such contexts, as the communities in the wetland have understood. This risk perception study from Kenya therefore emphasizes the importance of social science research in terms of NTDs in special settings, particularly among those hardest to reach such as nomadic pastoralists, usually the same groups mostly affected by NTDs, in order to prevent such diseases.

4.6. Adverse health effects arising from agrochemical use

The adverse health effects that the application of agrochemicals to the farmers' fields is creating were largely addressed by the respondents in the Ewaso Narok Swamp. Consequences of the use of synthetic pesticides, among other substances, were reported to include eye and skin conditions, severe respiratory problems, as well as adverse long-term health effects. Nonetheless, this common practice continues in order to increase the agricultural yields in the swamp. There is vast evidence of the use of agrochemicals creating health risks in wetlands (Fuhrimann et al., 2015), varying by the specific pesticide class and exposure level due to spills, splashes and inadequate worker protection during production, application and/or disposal, or interaction with contaminated water (Julian and Schwab, 2015; Rogers and Randolph, 2015). Here again, safe drinking water, sanitation and handwashing facilities, as well as the application of protective health measures are crucial in the prevention of agrochemical-related health risks.

The impacts of pesticides are not only harmful to human health, but also to ecosystem health, degrading the soil, water quality, and all kinds of physical parameters that are necessary to ensure the foundation of the livelihoods that such wetlands provide, most importantly water and food production.

The adverse health effects of agrochemicals were largely perceived as risky by the target population and the experts in the Ewaso Narok Swamp. The effects of agrochemicals made up a large part of the communities' perceived health concern, which underscores their importance in the context of wetland use.

4.7. How to shape a health-promoting wetland management

This study captured a range of perceived occupational and domestic health risks that potentially expose wetland users to water-related infectious diseases, all of which are owed to the intense hydro-social interaction and change present in the highly fragile semiarid Ewaso Narok Swamp. Immense use of the water resource accompanies severe environmental degradation and pollution. These processes reduce the quality and quantity of available water resources, while concurrently, the deficient sanitation and sewage disposal infrastructure intensifies the extant health hazards (Anthonj et al., 2016; Derne et al., 2015). Thus, health-promoting wetland management is indispensable for the promotion of human health.

In the study area, the health-protective measures taken up by the wetland users are limited (Anthonj et al., 2016, 2018a), and much fewer than in rural Western Kenya (Githinji et al., 2010) or in an Ugandan wetland (Isunju et al., 2016). This relatively lower uptake of protective health measures does not necessarily highlight the deficits in the awareness, health risk perceptions and knowledge on transmission pathways. As this study revealed, there is a good understanding on the interlinkages of water, health, environment, human activity and wetland use, livestock interaction, and modes of disease prevention among the target population, all of which could be used in order to improve the health situation in the wetland communities. The explanation for the ‘unhealthy’ behaviour seems to lie in the limited access to adequate WaSH infrastructure (Anthonj et al., 2016) rather than a knowledge-to-action-gap. Despite more targeted health education and risk communication being potentially necessary in the investigated wetland, improved water use behaviours can mostly be achieved in conjunction with the overall prevention of contamination, the provision of adequate sanitation and the preservation of the ecosystem (Derne et al., 2015). The diseases could be reduced considerably through health-promoting interventions and implementation efforts, some of which are already being addressed in the study area. Numerous health-promoting wetland management options that accurately mirror the risk perceptions in the Ewaso Narok Swamp were recommended by both the target population and experts (Table 2).

Varied challenges are present in this semi-arid wetland's ecological situation that serves different interests and has numerous stakeholders involved in the use and management. All the stakeholders must be represented in a health-promoting wetland management if it is to succeed. Health-promoting wetland management calls for a sensitive, integrative approach which will not leave behind any of the humans, ecology, and animals affected, especially in view of increasing use and

Table 2
Recommendations to improve a health-promoting wetland management.

	Recommendation	Summary of key points
1	Improving provision of safe drinking water	- Provision of improved drinking water, available and within reasonable reach from the households and work places and safe water storage options. - Construction of water pipes and storage tanks by the government. - 'Half' programme to help people finance their water tanks for safe storage. - Delivery of liquid water treatment solution. - Teaching best practice in order to prevent mosquitos and contaminants.
2	Upscaling of sanitation coverage	- Improvement of sanitation coverage across the Ewaso Narok Swamp, identification of households in need through the CHW. - Awareness raising campaigns on flying toilets. - Education of communities that practice open defecation about the risks. - Teaching of responsible sanitation provided by PHOs & CHWs.
3	Changing hygiene behaviour	- Encouragement of a behaviour change by health education programmes on hygiene-related risks in close collaboration, interaction and participation. - Provision of better housing options, better constructed, well ventilated. - Special focus on the pastoralists, as they have the most limited options. - Hygiene education through local leaders and community health workers.
4	Establishing a waste management system	- Need to establish an adequate waste management system for domestic waste, wastewater, and agricultural by-products.
5	Adopting simple environmental options	- Preventing stagnant water, cutting grass and papyrus, clearing the bushes, planting trees, removing open water containers, burning cow dung to keep mosquitoes away and getting rid of the waste by digging pits. - Going for local options with necessary resources found within the communities. - Spread health education messages to everybody in chiefs meetings to. - Provision and promotion of insecticide-treated bed. - Include such considerations in public and preventive health strategies.
6	Reducing occupational health risks during farming	- Encouragement of farmers to wear protective gears, affordable provision. - Overall avoidance of water mismanagement. - Health education could target occupational health risks and precautions when applying agrochemical substances, and the risks to the environment. Dissemination through agriculture extension officers in the wetland.
7	Targeting pastoralists	- Provision of improved access to water for the pastoralists by construction of dams, e.g. through the County Government. - Education forum to create awareness on the hygiene-related risks to encourage a separation of animals and humans in the homestead. - Establishment of areas for farmers or livestock only to reduce user conflicts. - Limiting the access of animals to watersheds through measures such as fencing waterways and providing alternative sources of drinking water to animals.
8	CHW's role in health management & information dissemination	- Community health workers could play a crucial role in spreading health-, risk-, and WASH-related knowledge and best practice behaviour to the community. - Strengthening their role in health management and health education in order to engage with underserved and hard-to-reach populations in wetlands.
9	Improving collaboration to achieve a health- promoting wetland management	- A multi-sectoral, multi-actor and multi-level One Health response is required, especially in view of increasing use and land use change reducing and polluting the already limited water resources and food productivity of wetlands. - Need for collaboration among wetland and water sectors, the health sector, education and training, gender, agriculture and fisheries, development, infrastructure, transport, housing, trade and tourism at different levels. - The grassroots reality and participation of the target population is essential.

* This table refers to statements made during in-depth interviews with experts and the target population in the Ewaso Narok Swamp.

land use change that reduce and pollute the already limited water resources and food productivity of the wetland. It is of utmost importance to prevent water-related infectious diseases as these are a major roadblock to sustainable development (Finlayson and Horwitz, 2015).

Health-promoting wetland management lies within the scope of the One Health approach, which originated from the convergence between human and veterinary health in the context of zoonotic diseases (Cook et al., 2004). It requires an EcoHealth approach, which stresses the inclusion of the environment into this concept and emphasizes sustainable development and transdisciplinarity as main engines for implementation (Zinsstag, 2012).

Our results underline the tremendous importance of ecosystem stability for the functioning of key health-promoting services, with integrative and holistic approaches as the most promising tools for implementation. This study navigates One Health with its strong emphasis on how diseases of humans (and animals) are influenced by the environment, and Ecohealth, with a focus on ecology and its relationships to sustainability and interdisciplinarity. It shows that a broad range of stakeholders is necessary for success in achieving sustainable health-promoting wetland management. Collaboration, with an emphasis on grassroots perception and participation of the target population, is necessary (Finlayson and Horwitz, 2015; Horwitz et al., 2012; Leemhuis et al., 2016; Mungai et al., 2004).

4.8. The relevance of risk perception studies for healthy behaviour and health-promoting wetland management

This study shows that communities' risk perceptions realistically reflect health risks present in wetlands, health threats that poor WaSH creates for communities, the seasonality of diseases, the difference in disease exposure among different occupational groups, the risks associated with the use of agrochemicals, and the peculiarities in terms of health risks in semi-arid wetlands. The facts that (i) the perceptions correspond to the actual risks, and that (ii) the emic perspectives of the community members in the wetland allow for a more detailed, more realistic picture of the situation, make such sources of information invaluable. Risk perception studies, particularly in data-scarce settings such as the Ewaso Narok Swamp, are highly precious for capturing the situation and challenges that communities are facing.

Moreover, the subjective perceptions and judgements of affected individuals towards health hazards are vital in the management of health and the control of diseases in wetlands. Risk perception studies that acknowledge wetland users as valuable key informants reveal potentials to health officials and wetland managers. They have the

potential to reflect the actual risks, as well as the shortcomings of an area. Concrete recommendations to improve health-promoting wetland management can result from such a study (Table 2). Additionally, health risk perceptions are closely linked to and can motivate the application of positive health-related behaviour, as shown in evaluation of water and sanitation programme implementation in rural Ethiopia by Anthonj et al. (2018b), thus providing an entry point for informing targeted health messaging and health-related interventions in wetlands based on the shortcomings identified. These implications make risk perception studies among wetland communities a potentially supportive tool for an improved health-promoting wetland management.

Risk perceptions entail the potential of motivating positive behaviour. However, they are often not reflected in the individual health behaviour. In the Ewaso Narok Swamp, the pastoralists had more distinct health beliefs, which led them to use surface water sources for bathing, as this was perceived as health-promoting and healing (Anthonj et al., 2016). This shows that the cultural and traditional understanding of the 'real' causes of illness goes far beyond and can contradict the biomedical concept of health and disease risks (Rahman et al., 2012).

Risk perceptions do not necessarily translate into health-seeking behaviour. It is influenced by a wide range of factors, which also covers physical, socioeconomic and demographic aspects, and traditional preferences rooting in health beliefs. While the decision on whether or not to seek healthcare may be subject to a cost-benefit analysis, a question of priority, an indicator for the severity and duration of the perceived symptom(s) or disease (Hjortsberg, 2003; Rahman et al., 2012), religious convictions, health beliefs, social stigmata, and (mis) conceptions about the healthcare sector are decisive factors as well (Salako et al., 2001; Shayo et al., 2015). These can also go beyond, or in some cases even against, the biomedical understanding of diseases. Some illnesses are simply perceived as 'not for hospital', are treated by traditional healers or herbalists, by self-treatment or not treated at all (Anthonj et al., 2018a; Kleinman, 1980; Nichter, 2008; Singer and Baer, 2012). As described by Dunn et al. (2011) and Munguti (1998), cultural health beliefs and practices might lead to inappropriate and/or inadequate preventive health measures, treatment and delays in seeking healthcare, all of which may result in complications. Thus, while the overall risk perception was high and accurate among wetland users in Kenya, this does not necessarily allow for assumptions about the local ways to deal with ill-health and health-seeking.

4.9. Methodological discussions and limitations

This study aimed at (i) capturing the health-related knowledge regarding prevalent water-related infectious diseases, at (ii) investigating the risk perceptions among community members in the Ewaso Narok Swamp, and at (iii) proposing strategies for improved health-promoting wetland management.

It attributed individuals and households to different groups based on the users' interaction with the wetland and occupational characteristics, thus, their contact with water. Classifying the users by wetland interaction was beneficial for disentangling specific water-related health risk perceptions. A clear separation of groups, however, simplifies the picture of household income, as livelihoods have shown to be highly complex, diversified and rarely dependent on a single income or occupation (Barrett et al., 2001; Ellis, 1998; Guyer and Peters, 1987).

Although a significant part of the design and training for this study was dedicated to the (re-)translation of health-related concepts beyond biomedical terminology in the multi-cultural context of the Ewaso Narok Swam through the support of research assistants of different ethnic affiliations, it is likely that health beliefs and understandings of health and ill-health were lost in translation. Numerous misconceived health beliefs were manifested especially among the pastoral nomads. Such included malaria being caused by rain or by floods, pesticides and even by elephants; diarrhoeal diseases in children appearing as a consequence of them teething; skin and eye diseases being caused by the weather; health protection or diseases caused by witchcraft. The cultural understanding of the 'real' causes and the 'meaning' of illness goes far beyond the biomedical concept of health and diseases (Dunn et al., 2011; Hausmann Muela et al., 1998; Kamat, 2006; Malisa and Ndukai, 2009; Pool, 1994; Rahman et al., 2012), which to fully capture perceived risks must be understood in more detail.

A limitation lies in the cross-sectional design of the survey questionnaire, which could only capture the risk perceptions at one point of time and thus not fully account for risks in different seasons and years, and which a longitudinal design could have been useful for. However, the triangulation of mixed methods, particularly the open-ended questions following the survey, as well as qualitative data helped to close potential information gaps.

5. Conclusions

Since the trend of increasing wetland use is unlikely to be reversed but rather more likely to be exacerbated, and the use of wetlands is closely associated with the risk of contracting water-related infectious diseases (Anthonj et al., 2017), it is necessary to capture the challenges of wetland communities to facilitate healthy wetland use, and to decide future steps, including possible interventions.

Health, the foundation for work productivity, food security, poverty reduction, economic growth, and long-term development, needs to be protected in the context of wetlands. However, global action to achieve health-promoting wetland management is limited.

By showing that the health risk perceptions among wetland communities reflect the actual health risks and shortcomings in the Ewaso Narok Swamp, this study contributes to wetland and health research. Most importantly, itunderpins and acknowledges the role of wetland users as key informants. It demonstrates that risk perception studies and recommendations from the grassroots level, can serve as helpful tools for health-promoting wetland management.

As falling ill impairs the users' productivity and quality of life, further research should compare the level of risk perception to the level of risk prevention and health-promotion activities in the targeted population. Overall, it is crucial to integrate risk perceptions into health-promoting wetland management activities, health education programmes and disease prevention as well as control strategies.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.ijheh.2018.08.003.

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