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Household vulnerabilities at the intersection of water, energy, and food in urban Zimbabwe: A social practice perspective on seasonal variabilities

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Abstract

Communities in most urban areas of low-income countries struggle with vulnerabilities at the intersection of water, energy, and food (WEF). This paper focuses on how individuals and communities engage, negotiate, and perform social practices in their daily lives at the intersection of WEF in the face of seasonal variability and household vulnerabilities. This study embraced a qualitative research method. Data from 35 interviews and two focus group discussions was administered to urban residential households. These were conducted across three settlement types based on land size and economic status. Key informant interviews with policymakers were also conducted. The study showed that low-income areas in Harare rely on precarious water and energy sources for cooking. Recurring droughts are increasing power cuts fueling deforestation. Energy poverty is severe, especially in informal settlements which are not connected to the power grid. The use of sawdust for cooking in winter is common in poor households because it is affordable. However scavenging saw dust is dangerous and difficult in the wet season. Recycled water is used for household general use. In winter, backyard gardening is abandoned due to water shortages, resulting in lack of dietary diversity. To policy makers, findings show the importance of understanding the nexus of practice problems, climate change and WEF vulnerabilities. Results also demonstrate the importance of interconnecting the social practices performed at WEF nexus to address household challenges for sustainable cities. Results also inform the service providers of better ways to improve service delivery.

Keywords: Adaptation; Water-energy-food nexus; Social Practices; Urbanization; Vulnerabilities; Sustainability; Climate Change

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1. Introduction

The water, energy, and food (WEF) nexus are an SDG framework (Biggs et al., 2015; Terrapon-Pfaff et al., 2018) that can be used to resolve related challenges at a household level (Ningi et al., 2021). The World Economic Forum and the Bonn conferences supported the interconnectedness between WEF natural resources and the negative effects this can have on the environment if not properly managed (Biggs et al., 2015; Shah, 2016; Simpson and Jewitt, 2019; Caputo et al., 2021; Wahl et al., 2021). In the same manner, Breadsell et al. (2019) and Duarte (2022), acknowledged the interconnectedness of social practices and the importance of incorporating sustainability in the provision of services such as WEF. WEF resources are needed in fulfilling everyday practices such as bathing, cleaning, laundry, cooking, or heating (Breadsell et al., 2019). Although it is known that higher proportions of greenhouse gas (GHG) emissions in the cities are from the industrial and transport sectors, current research has established that it is also increasingly being driven by household energy services (IEA, 2008; Okaka and Odhiambo, 2018; Filho et al., 2019). Hence the WEF crisis in urban areas has been one of the top priorities on the agenda for sustainable development. High rates of urbanization in the face of climate change have increased demand for the three basic resources, amplifying household vulnerabilities in turn affecting the performance of social practices. It is therefore important to seek sustainable social practices for managing WEF resources for sustainability at a local level.

There is limited information on how resources are efficiently and sustainably managed at a household level. This situation is worsened by an increase in informal settlements experiencing WEF exclusion (Giatti et al., 2019) forcing residents to rely mostly on unsafe water sources, traditional fuels, and rampant extensive agriculture (Adams and Smiley, 2018; Foster et al., 2018; Ndebele-Murisa et al., 2020; Kamusoko et al., 2021). Informal settlements are often excluded from essential service provisioning such as on-grid connections and portable water service delivery due to the nature of their illegal characteristics and they experience stigmatisation perpetuating urban inequalities (Granero de Melo et al., 2020; Mguni et al., 2020). Although since the 1960s, Governments are embarking on upgrading schemes to provide the missing infrastructure, the improvements are often inadequate to reduce the residents' exclusion from public services (Satterthwaite and Sverdlik, 2021). Residents in the periphery are also excluded or poorly served in terms of WEF and other social services which support the nexus (Giatti et al., 2019).

Regarding local knowledge and social practices, inequalities exist in such a way that residents in the peri-urban areas also have major cognitive exclusion. They do not have knowledge about social practices. Access to information is important for sustainability. WEF sectors are interlinked, and so are their social practice challenges, adaptation practices, and effect on the environment (Nhamo et al., 2020; Terrapon-Pfaff et al., 2018). All three sectors are highly vulnerable to climate change which is a threat to development and environmental sustainability due to GHG emissions (Leck et al., 2015; Zografos et al., 2016; Mpandeli et al., 2018; Filho et al., 2019; Sivakumar, 2021). This is because of a continuous reflection of poor access to safe and clean water, unaffordable energy, and food, in particular for urban areas, hence increased poverty (Hake et al., 2016).

The variability of seasons due to climate change has greatly affected how communities perform social practices in their everyday life. However, social practices are invisible hence little attention has been focused on them (Balke et al., 2014). Recently attention has shifted from individual decision-making to daily activities. Furthermore, not much research has been done on how the WEF nexus affects social practices and yet

consumption of these resources is interwoven in practices that are interrelated (Breadsell et al., 2019). Studying the discreet elements of social practices can inform policy on socially sustainable practices to safeguard the environment. Transforming the social practices for sustainability is more effective than persuading the individuals for pro environmental behaviour (Hargreaves, 2011). Understanding the daily functioning and importance of social practices is crucial to policy makers in order to improve sustainability.

This research explored the performance of social practices at the intersection of WEF in the face of seasonal variabilities and household vulnerabilities in Harare. It specifically highlights how households engage, negotiate, and perform the practices in their daily lives. It also gives an insight into households' coping mechanisms to the impacts of climate change and urbanisation.

2. Literature review

The demand for water, energy and food is increasing worldwide. There is an imminent global energy crisis. A global water crisis is also looming, yet energy and food production are highly water intensive. Agriculture being the largest consumer of water, while most of the forms of energy are produced using water. Around 768 million people worldwide remain without access to an improved source of water, 1.3 billion people still lack access to electricity and about 868 million people are undernourished due to a lack of food or lack of access to food (Sivakumar, 2021). Rapid urbanisation is also putting a lot of pressure on water, energy, and food resources.

The achievement of clean air and a stable climate under the WHO guidelines and the Paris Agreement require a rapid phase-out of fossil fuels (IPCC, 2014; Lelieveld et al., 2019; Zarei et al., 2020). Numerous scholars have noted that adjusting to climate change and its known vulnerabilities related to WEF resources in urban areas has created major challenges for sustainable urbanisation (IPCC, 2014; Romero-Lankao et al., 2017; Romero-Lankao et al., 2018; Terrapon-Pfaff et al., 2018; Covarrubias and Boas, 2019).

It is important to know and understand the experiences of the urban poor people where the WEF nexus is concerned (Mguni and Vliet, 2020). According to Shupler et al. (2021), the choice of household fuel type used for cooking depends on its availability and cost, and it determines household dietary diversity. The fuel choice also depends on household income, size, frequency of cooking, and type of food to be cooked. Barriers to cooking in Kampala for example, result from trade-offs between energy (charcoal) and adequate food and safe drinking water (Mguni et al., 2020). Unaffordable charcoal, quantity, and quality of charcoal, alleged padding of charcoal tins by charcoal vendors, inefficient charcoal-production practices, and charcoal conservation practices were barriers to cooking in some households. Lack of energy in Kampala hindered water purification and the consumption of high protein value food since they demanded high energy (Mguni et al., 2020). Unequal access to clean and safe water in informal settlements adversely impacted daily domestic activities, such as cooking and drinking, signifying vulnerabilities (Mguni et al., 2020; Granero de Melo et al., 2020).

High adaptive capacity does not always translate to reduced vulnerability (Elrick-Barr et al., 2014). In Australia, one community's response to a heatwave was a threat to the adaptation efforts due to low adaptive capacity and the fact that it was a short-term reaction (Zografos et al., 2016). Inequalities in water storage systems were noted between the poor and the high-income in Mexico and Kampala. The high-income residents used large water tanks leaving the poor more vulnerable and sometimes fetching water from unsafe sources (Eakin, 2016; Granero de Melo et al., 2020; Mguni et al., 2020). Water storage was associated with a system known as circulation in the neighbourhood when those with smaller tanks travelled long distances on rugged

steep terrain with one or more buckets to fetch water, an indication of amplified vulnerability (Eakin, 2016; Granero de Melo et al., 2020; Mguni et al., 2020). In Guarulhos in Brazil, according to Giatti et al. (2019), some families produced and sold fresh foods in the neighbourhoods. Their gardens used chicken manure partly produced locally for fertilizer, and water from the public supply for irrigation. However, they mainly distributed the vegetables and other greens in the areas closest to their home, using a handcart, leaving far away areas vulnerable.

Among the various approaches used by different authors to illustrate nexus challenges and vulnerabilities among a population, the social practice perspective appears to be dominating (Mguni et al., 2020; Mguni and Vliet, 2020). Placing social practices in the nexus context gives an insight into the challenges and changing dynamics of WEF provisioning in Harare. Numerous authors (Gulati et al., 2013; Giatti et al., 2019; Granero de Melo et al., 2020; Hiteva, 2021; Mguni et al., 2020; Mguni and Vliet, 2020; Covarrubias and Boas, 2019) have used the social practice model to explain dynamics of existing challenges at the nexus in the contexts of their research. Mguni (2020) examines the challenges and vulnerabilities emerging and hindering cooking-as-a-performance in Kampala, Uganda. Giatti et al. (2019) explore the challenges of food and clean water provisioning for a population with limited access to these resources and the health implications. Hiteva (2021) explores the vulnerabilities to food and fuel insecurities experienced by a vulnerable population and linked them to pollution. Granero de Melo et al., (2020) also use the social justice practice to improve food distribution and restore the local ecosystem in a vulnerable community struggling to gain recognition. Covarrubias and Boas (2019) highlight greening urban food systems through improving proximity to food in Barcelona.

Tackling household WEF challenges effectively requires an integrated approach. The relationship between WEF resources is complex because each aspect within the nexus should be addressed to reduce vulnerabilities (Nepal et al., 2021). Water plays a leading role in the WEF nexus (Al Saidi, 2016). Food production and energy generation require a large amount of water. According to Chen et al. (2018), adopting water-saving technology/measures such as ground water-saving irrigation technologies and water harvesting tanks becomes necessary to address water shortages.

Previous studies have focused mostly on technical assessments and less on the social household angle and yet it is at household level where major challenges occur (Biggs et al., 2015; Terrapon-Pfaff et al., 2018; Leck et al., 2015). Furthermore, no detailed paper has been done demonstrating the links between access to sustainable WEF issues at a lower level (Terrapon-Pfaff et al., 2018). Major nexus challenges are faced at the local level (Mahlknecht, et al., 2020). There are also challenges in finding appropriate optimisation approaches at a local level (Caputo et al., 2021). At local levels, the nexus gives details of WEF challenges related to the communities' behaviour, access to resources, equity, and governance (Caputo et al., 2021). Resource accessibility, availability, and quality are not sufficiently addressed in current frameworks (Purwanto et al., 2021) and impact (Enríguez-de-Salamanca et al., 2017).

This paper analyses vulnerabilities at the WEF nexus with a focus on how households engage, negotiate, and perform social practices. It also highlights coping mechanisms and possible implications on the environment with the aim of finding socially sustainable practices in the provision of WEF services. The paper uses the social practice model. Social practice models place the environment at the centre of sustainable development (Southerton et al., 2004). Emerging vulnerabilities and challenges and factors impeding the performance of social practices such as cooking, bathing, showering, and gardening at the WEF nexus in Harare are explored.

3. Research methodology

The research focused on a case study of Harare Metropolitan City in Zimbabwe as it has been strongly affected by climatic change and urban vulnerabilities have been heightened in the wake of the now-becoming perennial WEF challenges and increasing climate effects. The paper is informed by a qualitative research design. Data was collected in two phases, first in mid-November when the dry season was at its peak: immediately before the onset of the wet period. The second collection phase was in mid-February when the rainy season was at its peak. This was done to better understand the dynamics of social practices in different seasons. The study is based on case studies of 35 in-depth interviews and two FGDs with Harare residents. A multi-stage sampling approach was used. In the first stage, purposive sampling was used to identify the five constituencies within Harare Metropolitan Province. The five settlement types were identified based on land size and economic status. Informal settlements have very small land sizes and high poverty prevalence. The formal settlements have a high economic status, serviced larger land sizes comprising high, medium, and low-density areas. In the second stage, suburbs were randomly selected and the criteria for selection was based on settlement type (formal and informal) and population density (low, medium, and high). A total of seven suburbs in five settlement classification types were then included in the research. In the third stage, the respondent households in each identified residential area were selected randomly, though the actual respondents per household were purposively selected. Either the household head or an adult was interviewed at each selected household. The household was the sampling unit in this study because it is where all decisions are made on a daily basis.

Eleven in-depth key informant interviews with the relevant authorities, two with the community resident association, and 2 FGDs (22 participants) were undertaken. Purposive sampling was applied to select interview participants. A four-stage analysis model was applied to analyse and interpret qualitative data collected during the study. This comprised four steps that included collecting and processing data per each residential area, writing case studies per each residential area, reading all case studies, and identifying trends and writing a study report based on themes and trends in common threads. Data for each residential site was processed using a desktop matrix in which the analysis of emerging themes from the transcripts was used. Transcript contents for each settlement area were populated in line with emerging or identified themes. Common threads and peculiarities between high-income and low-income residential areas were identified and comparisons of the qualitative data across settlements were made. An analytic review of the data assisted by peer-critical appraisals through recorded discussions resulted in a more in-depth unpacking of the data.

Given climate change-related challenges there is a need to expedite changes in societal consumption patterns by using approaches that go beyond the individual (Kennedy et al., 2013). In this study the social practice model is used to explore factors influencing human behaviour in an effort to instill pro environmental behaviour. As acknowledged by Southerton, (2004), factors including individuals' beliefs, attitudes and values can be used as predictors of behaviour and can be improved to stimulate behaviour change. The focus is more on social practices and how they are organised in households. Humans are agents that act within structures of social practices (Figure 1), that is, they perform practices. In the model, the focus is on practices that are deconstructed into discreet units that are interconnected. In Figure 1, WEF nexus is represented by social practices of cooking, lighting, showering, etc. that are interconnected.

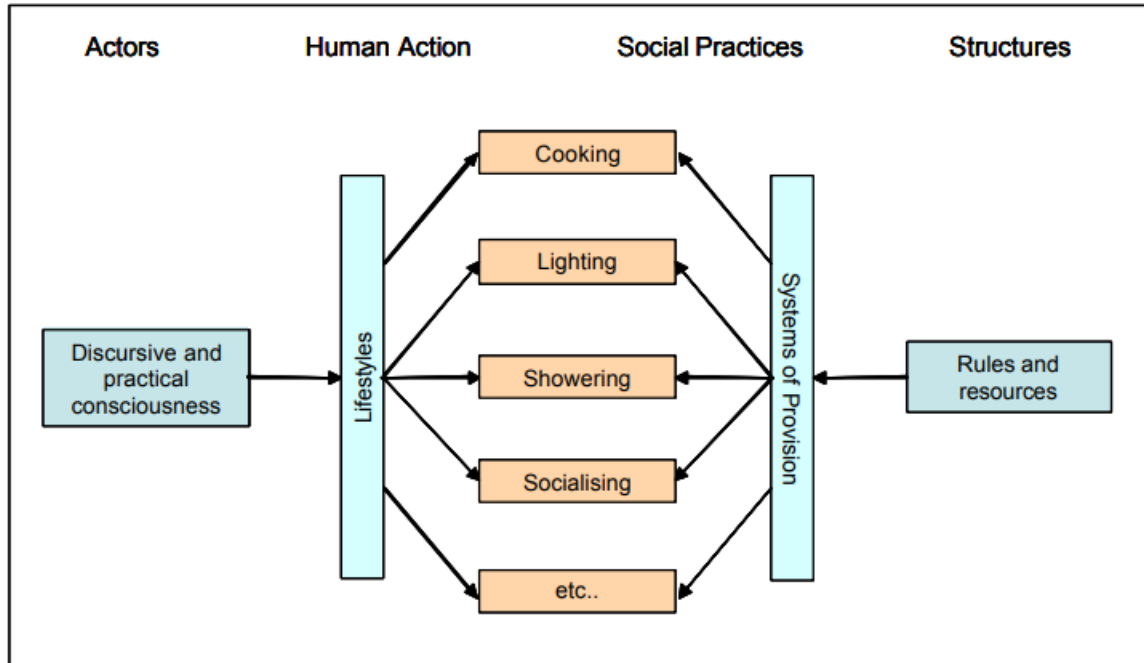


Figure 1. Consumption as Social Practices (after Spaargaren and van Vliet 2000)

Social practice models present a people’s lifestyle in terms of WEF provisioning and consumption and provide an insight into the pattern and complexities of everyday practices among vulnerable households. In this study, the performance of these social practices has been affected by seasonal variabilities which affect systems of provisioning and, in turn, influence communities’ response to WEF vulnerabilities.

Regarding consumption behaviours, the distinction between ‘practical’ and ‘discursive’ consciousness in structuration theory should be appreciated. According to Giddens (1984), human action in everyday life hinges on practical consciousness, that is, the everyday knowledge that people have on how to do things which depends on commonly accepted knowledge concerning how to go about things. It is the practical consciousness that makes one search for firewood to cook, find safe water to drink, and grow vegetables in the garden to improve food security. Most of our practices take place at the level of practical consciousness, where we just act without thinking about it. However sometimes we operate at the level of ‘discursive consciousness’ – where we reflect on how we did things, though sometimes we find it difficult to talk about our actions. Knowing the difference between practical and discursive consciousness is important in motivating pro-environmental behaviour, creating learning possibilities and opportunities for awareness raising. Spaargaren and van Vliet (2000), suggested the importance of shifting consumption patterns from the level of practical consciousness to discursive consciousness. Daily social practices are determined by social norms and lifestyle choices and by institutions and structures of society. Discursive consciousness is important in creating strategies to change the usual behaviour.

A practice is held together by resources, norms, and infrastructure (Spaargaren, 2003). This research focuses on household practices, experience, and seasonal vulnerabilities in accessing WEF resources with the intention of establishing sustainable adaptive practices among households. Social practice models link agency and structure. Agency is the capacity of individuals to have the power and resources to fulfil their potential (Spaargaren, 2003). Consumption is also determined by norms and contextual factors. Social practices are

characterised by collectiveness in a community and further understood as the locus for knowledge to occur (Giatti et al., 2019; Mguni and Vliet, 2020). Social practices are important because they bring change to a society. For example, studies by Mguni et al. (2020) in Uganda, Giatti et al. (2019) and Granero de Melo et al. (2020) in Brazil and Hiteva (2021) in Bulgaria revealed that water restrictions have limited and increased the challenges of daily household domestic social practices such as gardening, showering, and cooking. Social practice models explore the relationship between human action and the social institutions that institute the framework for human action (Jackson et al., 2005). They focus on people's behavioural practices and the possibility to reduce environmental impacts of the normal socially shared daily activities such as cooking, bathing, and farming that are organised and recognisable (Mguni et al., 2020). According to Giddens (1976, 1984) in his structuration theory, humans find security in social interaction (Jackson 2005). Giddens (1984) recognises humans as having reflexive and contextual knowledge that makes the structure of the society institutionalised.

4. Findings

4.1. Social practices and vulnerabilities at the WEF nexus

The challenges posed by climate change and rapid population growth demand an insight into WEF consumption in the home, the community, and society at large. Social practices are shaped by social, technological, and psychological factors as Breadsell et al. (2019) puts it across. In this study, the household context, psychological, economic status, technological, and environmental factors determine the practices that exist.

In the face of climate change and urbanisation, households struggle with engaging, negotiating, and performing their daily social practices at the intersection of WEF in urban areas. Response to these vulnerabilities and struggles depends on the magnitude of the problems which, in turn, are a factor of seasonality and capability. Table 1 shows affected social practices, the influence of seasonal variabilities, and the extent of vulnerabilities in performing these social practices at the WEF nexus.

Table 1. Social practices, vulnerabilities, and seasonal variabilities selected for the social practice model

Selected Social practices at home	The dynamics of Seasonal variability and WEF	
	Summer	Winter
Drinking	Underground water recharges	Water table retreats deeper
Cooking	Underground water recharges Sawdust excavation dangerous Limited space to dry saw dust and wood Prices of gas escalate High, escalating and unstable prices of electricity	Water table retreats deeper Saw dust excavation Wood fuel Charcoal Gas High, escalating and unstable prices of electricity

Table 1. Count.

Selected Social practices at home	The dynamics of Seasonal variability and WEF	
	Summer	Winter
Laundry	Underground water recharges	Water table retreats deeper Recycled water is used
Bathing	Underground water recharges	Limited water
Watering the garden	Backyard gardening resumes Dietary diversity	Backyard gardening ceases Lack of dietary diversity
Flushing the toilet	Water availability and accessibility improves	Water availability and accessibility improves
General cleaning	Water availability and accessibility improves	Use of recycled water
Refrigeration	Power cuts have increased	Power cuts have increased
Ironing	Use charcoal	Use charcoal
Heating	Sawdust and wood fuel	Saw dust and wood fuel
TV/ Radio use	Use solar	Use solar
Charging phone	Use solar	Use solar
Pumping water	Use solar	Use solar

The social practices listed in Table 1 are the ones that were brought up where adaptation to household WEF vulnerabilities resulting from seasonal variability were discussed. In addition, these practices are also interlinked. Practices like drinking (of water), cooking, laundry, bathing, watering the garden, flushing the toilet, and general cleaning were found to be affected by seasonal variabilities.

Figure 2 shows the practices that residents indicated they are struggling with. It also shows the interlinkages of these social practices within the context of WEF.

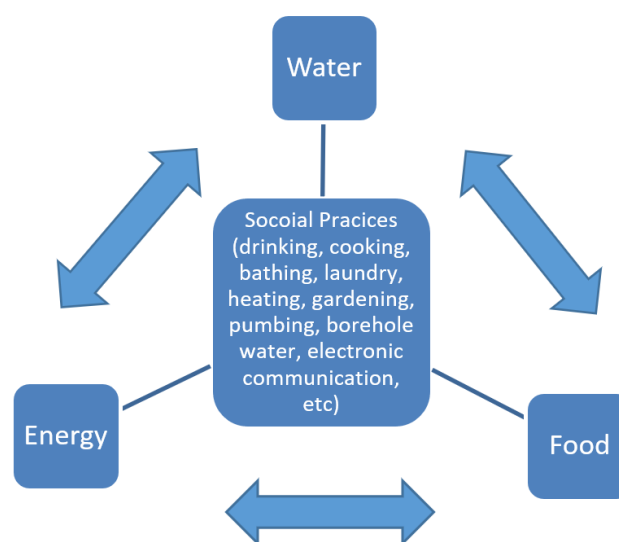


Figure 2. Social Practices interlinked at practice and unit level

According to Figure 2 the practices are interlinked both at a practice level and at an element level. For example, at a practice level refrigeration, ironing, heating, and electronic communication have resulted in more energy use, and gardening, cooking for food, laundry and bathing use water. The WEF nexus is also evident at a unit level. For example, water is used for the production of energy and food.

4.2. Settlement type and WEF provisioning and consumption

WEF provisioning and consumption at a household level is influenced by people's practices and behaviour. Settlement type and socio-economic status were found to be determinant factors in household choice of WEF adaptation practices in Harare. Variations in access to WEF resources to perform various social practices were also noted within the different urban communities. Findings from interviews in low-income areas revealed that households struggle to access clean adequate water, affordable energy, and adequate quality food among other challenges. In summer, water for showering and gardening is limited. The low-income areas comprise formal and informal high-density settlements. The former is connected to water and energy services but do experience water and energy provisioning challenges resulting in struggles in lighting, bathing, watering the gardens, laundry, ironing, refrigeration, and other daily social practices. The latter experiences a situation of what Giatti et al. (2019) terms 'energy exclusion' and 'exile periphery' which is a major cause of urban inequalities. This is whereby these informal settlements are excluded from network services because they are illegal settlements; which also result in experiences of stigmatisation (Granero de Melo et al., 2020; Mguni et al., 2020). In his structuration theory, Giddens (1984) argues that such a vulnerable society has a contextual background and possesses knowledge and intuition which makes it operate at a level of 'practical consciousness'. This was found to be the case in this study. Households/communities first understand the problems at hand, for example, in the context of this research, these include economic crisis, low income associated with poverty, climate change, and seasonal variability, unaffordable and erratic power and water supplies. This determines the way households/communities perform social practices at the WEF nexus as explained in section 4.3. As a solution to their predicament, households search for alternative affordable fuel sources for cooking, water to drink, and growing crops in the garden to improve household food security. The residents are knowledgeable of their contextual factors. Under such difficult conditions, they are not concerned about 'how' they are accessing the resources and the impact of their activities on the environment. What is a priority to them is accessing the resources.

Within the peri-urban settlements in Harare, some households are connected to water and energy provisioning as a result of the government 'upgrading' policy where the aim is to improve quality of life through incremental provisioning of services and tenure among existing informal settlements. In response to the unreliable and inadequate supplies of basic services by the local authorities, households rely on ad hoc, haphazard, and short-term coping mechanisms for WEF resource shortages. This happens against the backdrop of illegal connections which are increasingly becoming common as most residents cannot afford high connection fees. Harare experiences power outages, load shedding, and brownouts due to intermittent seasonal rainfall. Households connected to piped water have not been receiving tap water for a long time due to poor service delivery. As alluded to by Gulati et al. (2013), in South Africa, as prices of energy and water increase, so do food prices with the vulnerable poor households in urban areas being the most affected. This is the same situation experienced in Zimbabwe. This situation determines how households perform at the point

of cooking, bathing, watering the garden, doing laundry, and lighting the house among other daily household practices.

4.3. Seasonal variability, WEF vulnerabilities and social practices

Countries in Southern Africa including Zimbabwe have been experiencing persistent droughts. Urban areas are the most affected due to limited coping mechanisms. Rainfall is experienced in the summer season which runs from the end of October through to late April. The highest rainfall occurs in late December to early February. The variability of rainfall is high with average rainfall decreasing from the North to South. Furthermore, according to Manjowe et al. (2020) there is a possibility of the rain season shortening.

Given that scenario engaging, negotiating, and performing social practices becomes a mammoth task and requires households to have a specific pattern where necessary. Vulnerability to water and food challenges increases at the end of the long dry winter season from May to September and the beginning of the local summer, that is up to the second half of October when the water table has retreated to deeper layers. The low-income vulnerable communities spend more time in long queues and travel long distances to fetch clean water for cooking and drinking. Water for bathing is recycled and used for cleaning the home and flushing the toilet. Most households in low-income settlements resort to using water from untrusted sources. Corruption becomes common with some water committees and, in addition, water vending increases. Similar findings were confirmed by Eakin (2016) in Mexican informal settlements in which the low-income vulnerable population sometimes buy water from local supplies and untrusted sources rather than from expensive national commercial suppliers. Respondents in Harare revealed that the use of 100 liter water wheelbarrows to fetch and store water is steadily growing and replacing buckets. This is reducing the number of trips to fetch water. There is extensive use of underground water leading to the depletion of groundwater resources. With population pressure and economic collapse, it should be noted that the responsible authorities cannot maintain high standards of service delivery and universal access to basic services for the citizens. The Zimbabwe National Water Authority (ZINWA), the country's raw water regulator, offers permits for borehole drilling but does not regulate and enforce the legislation (Ndebele-Murisa, 2020). The borehole proliferation in the city diverts the local authority from finding the right solution.

Research results also revealed increased abandonment of backyard gardening due to water shortages. Gardens are becoming common along streams where there is raw water from streams. Prices for fresh vegetables and nutritious healthy food are increasing, making it unaffordable for many people. Meals have been reduced to only two per day by many households regardless of their nutritious value. Some households are using sawdust for cooking because it is less expensive compared to other sources of fuel such as charcoal, gas, and paraffin. However, respondents revealed that sawdust is not easily accessible, it is wasteful, and cannot be recycled. Respondents also revealed that sawdust produces smoke that damages aluminum pots. They also revealed that scavenging sawdust from industries is dangerous, yet in some households, sawdust was used as a source of livelihood. Wood fuel was said to be difficult to procure because of the restrictive conservation measures. Residents source charcoal from neighbouring countries but the rising prices are prohibitive. Most households use charcoal only when they plan to iron that particular day because after cooking, the remains are used for ironing. There are also instances of practices that interlock with others to create a collection of practices that arise from socially shared knowledge, meaning, skills, or technology (Breadsell et al., 2019). These multiple practices take place at the same time/in a similar way as an everyday

routine, for example, bathing, cooking, warming the home, ironing, and going to work. In terms of resource consumption, these practices are determined by factors including household context, social economic factors, institutional arrangements, household context, and the environment (Breadsell et al., 2019). In this research seasonal variability and the household economic status were found to determine these practices. Seasonal variability was also revealed to influence energy sources in Sofia where vulnerable households scavenge the landscape collecting items left near and inside communal bins to supplement wood purchased for heating during the winter season (Hiteva, 2021). Those without space in their yards use their gardens to store some of the collected materials and return to their gardens in the winter months to ferry them to their homes. In Harare, there is an option of using solar cookers, but people do not have enough relevant knowledge for such a transition. In addition, this is also restricted by changes in climate.

Due to power outages and load shedding, households using electric pumps, even though they are few, are affected and water challenges and vulnerabilities in the communities are amplified. Households in the community rely on these few households that own electric boreholes. These households sell clean water for drinking to the community. Water is allocated with a limited quota, and it is expensive. Council water from communal taps is available once a week, on Monday but respondents indicated that it appears unclean for human consumption. On Mondays, some residents do not go to work and stand in long queues in an effort to secure water. Eakin (2016) revealed the same findings in the informal settlements of Mexico where residents missed work because water collection timeslots clashed with work hours. There is a nexus between the climate, water, and energy in Harare as confirmed by (Ndebele-Murisa et al., 2020). At a household level, the main sources of energy include wood fuel and hydropower, both of which rely on water in their production. Rainfall variability has lowered Kariba dam water levels leading to power cuts, load shedding, and intermittent brownouts. This has greatly affected the electric water pumps amplifying challenges of water and forcing people to search for alternative options that are potentially unsafe and harmful to the environment. Residents rely on unsustainable adaptation measures for survival, for example, shallow wells which utilise a rope fixed to a bucket to enable water drawing. These wells serve many people, which is something that further increases the risk of contamination from the point of source to storage at home.

In Harare, there is a mismatch between water demand and population growth, and this is worsened by a limited capacity to deal with increased wastewater (Ndebele-Murisa et al., 2020). If this situation is compared to Namibia, this should have been an opportunity. In Windhoek, Namibia infrastructure at wastewater treatment plants was upgraded in order to cope with an increasing urban population and treated wastewater is now a big proportion of domestic water supply. Mexican informal settlements also practice wastewater recycling from one use to the other organised by household members, particularly women (Eakin, 2016). A coping practice at the water-food nexus is evidenced through the use of water for backyard gardening for vegetable growing. This is especially evident during the wet season and applied to improve dietary nutrition. Recycled water is sometimes used for watering during dry seasons.

In Harare, summer (rainy) season which lasts from the second half of October to April, improves food security due to seasonal gardening/crop farming. Backyard gardening and open-space farming resume. Households are able to grow and cook fresh vegetables available from the garden. Flowers are replaced with vegetables. Although open-space farming is restricted by the expansion of the urban built-up area, those who own big gardens and large open spaces grow dry vegetables (mufushwa) maize (mumhare) and tomatoes for consumption during the winter season when fresh food is in shortage. Dried vegetable leaves and tomatoes

are used as relish, and dried maize (mumhare) is commonly mixed with cowpeas (nyemba) or roundnuts (nyimo) in preparing the main meals. Residents with larger plots in open space areas often grow beans which are harvested, dried, and stocked for use as relish during the dry season. Groundnuts are dried and stored for consumption (cooked or uncooked), sale, and also for use as seed (uncooked) for the next season. They are sometimes shelled and roasted. Unshelled groundnuts can be boiled, shelled, and then dried. The roasted and boiled groundnuts are nicely packed and sold in small packets at roadsides and markets. This has become a lucrative business for the communities as well as the grocery shops. NGOs including the Danish International Development Agency (DANIDA) and Plan International give food vouchers (allocated based on family size) to vulnerable households in informal settlements to supplement their food.

The local food production social practice in Harare also includes small backyard poultry projects. This has led to nexus linkages within WEF resources as some families use chicken manure from those backyard poultry projects to grow vegetables in open spaces for reselling in the neighbourhood. Giatti et al. (2019) noted the same practice of gardening for home consumption as well as selling Guarulhos in Brazil ultimately leads to improved local livelihoods.

There are other factors that influence how the discussed social practices are performed by households. For example, boiling beans demands high energy as confirmed by Mguni et al. (2020) in Kampala. Findings of the current research in Harare revealed that residents rely on charcoal to boil beans. Those who own refrigerators boil beans in large quantities and freeze some of them to ensure sustained access to ready-to-eat food over a long period of time. In response to frequent power cuts water is frozen in plastic containers when there is electricity and then used to continue freezing food when there is no electricity. Households in Harare experience vulnerabilities and challenges at the energy-food nexus when cooking high energy-demanding foods that include beans, dried maize, cowpeas, and round nuts. Electricity, charcoal, and wood fuel have become expensive and unaffordable thus compelling some residents to scavenge for sawdust, which is not readily available. Intermittent power outages, load shedding, and brownouts have adversely affected the system of boiling and storing large food quantities in refrigerators. This system is applied by some dwellers as a fuel saving practice. Power supplies are inadequate for meeting energy demand across Zimbabwe (Ndebele-Murisa et al., 2020).

During the dry season households experience food challenges due to water shortages. Producing and preserving food for the next season as an adaptive response to fuel poverty and seasonal vulnerability has also been revealed by Hiteva (2021) in Sofia (Bulgaria). In addition, the practices of zimnina making, urban gardening, and the use of alternative energy sources for domestic heating were used. In summer urban gardeners make zimnina, use their gardens, open spaces, and discarded materials to light fires that are needed to sterilise and close jars for storing zimnina. The jars are expected to last during the winter period. Open space farming is also prevalent in Harare and has the potential to help the vulnerable and poor in terms of food access, as well as to promote green energy use through solarising water pipes.

Due to open space farming, the food networks between Epworth, Hatcliffe, and the main urban settlement improved as the local farmers/families from the informal/peri-urban areas grow crops that they sell in Harare urban area. Mobile food/vegetable markets enabled the food flows between the informal/peri-urban and Harare urban areas. A similar case was found in Brazil by Granero de Melo et al. (2020) where experiences of food flow were between municipalities and Sepé Tiaraju settlement. The daily commuting between Epworth

and Harare urban areas is a critical coping strategy to ensure the maintenance and existence of Epworth and the sustenance of people's livelihoods.

In summer in Harare, the availability of water improves but energy challenges escalate. During the rainy season, sawdust scavenging, which is already a health hazard, becomes more dangerous. Furthermore, it becomes difficult to dry the sawdust because of the heavy rains. Some households run short of space to dry the sawdust in the rainy season and often sell it to get income. The price and availability of energy sources affect energy use patterns. Generally, gas was used for cooking in all settlements though usage was high in high-income areas. On the other hand, households with electricity connections are reluctant to use it for cooking or ironing because it is expensive. In response to load shedding, power cuts, brownouts, seasonal vulnerability, and high electricity bills, Harare residents rely on multiple energy resources including gas, electricity, solar, charcoal, and wood to meet their energy needs. Sawdust stoves are used for cooking and warming and coexist with solar or candles for lighting, sometimes in the same room. Similarly, in Sofia, Bulgaria, Hiteva (2021) noted that wood-burning stoves coexist with electric radiators, central heating, and air-conditioning to satisfy the households' diverse energy needs. Gas is reserved for cooking in the event of a crisis and especially during the rainy season. Noise from diesel/petrol-powered generators was common mainly in the evening when they are used for lighting and charging gadgets. Sometimes each room in a home will have an independent and different way of providing essential energy services. This is a classic demonstration of how energy performs in a nexus relationship with other resources in Harare.

The household struggles for survival are likely to increase the carbon footprint and challenge the principle of green living as alluded to by Hiteva (2021) in Sofia, Bulgaria. This research found that solar energy is mainly used for lighting in the households found in the peri-urban/informal settlements. However, the incorrect connection of the batteries and gadgets was observed with most of the systems malfunctioning. The respondents revealed that they lack knowledge of how the systems are repaired and maintained. A lack of spare parts from the shops was also revealed.

As highlighted above, it has been established that within the same communities, there are high-income households that own boreholes, sizeable gardens and use gas for household energy. This demonstrates inequalities in the urban environment that can become a hindrance to sustainability. High-income households experience energy poverty as a direct outcome of load shedding and power outages. However, some of these households are backed by generators. Some of these sources of water and energy, e.g., groundwater and generators, are associated with environmental challenges like groundwater depletion, noise and air pollution, and health challenges. Most households in low-income areas prefer solutions linked to improvements in water provisions to improve food production as a priority. However, those in the high-income bracket opt for improvements in the power supply.

The adoption of specific strategies in response to social practice problems was found to be determined by certain factors. Participants indicated a lack of resources, knowledge, appropriate skills, and motivation among others. The results seem to suggest that vulnerability in Harare urban is a function of lack of financial resources and lack of knowledge of correct usage of solar technology. In a similar study, Chigumira et al. (2019) indicated that impeding factors for solar adoption by households in Zimbabwe include poor quality products in the market and poor installations that have destroyed consumer trust in solar technologies, lack of information among potential customers about recent advances in technology, lack of standards around the provision of warranties and after-sales services, installation and maintenance for solar products. In Kerala, India, Prasad et

al. (2020)'s study indicated that the adoption of household solar was influenced by government subsidies, low prices and low cost of maintenance and awareness. This is what is lacking in the context of Harare.

5. Conclusion

Problems associated with social practices at a household level and vulnerabilities emerging at the nexus in Harare suburbs reflect a society struggling to cope with shortages that are heightened by seasonal variabilities. In the wet summer season, most households in low-income areas practice backyard gardening and open space farming to improve food supplies. Most households in the low-income areas use their shallow wells to source water for all domestic practices. However, energy challenges increase due to load shedding, power cuts, and brownouts. The long dry season lowered Kariba dam water levels and high rainfall variability in the summer season make it difficult for the dam to reach full capacity for hydroelectric power. Saw dust scavenging in the rainy season also becomes difficult and dangerous for low-income areas. Places to dry the sawdust is also limited. Food such as groundnuts, tomatoes, green mealies, beans, and cowpeas are dried for the next season. In the dry winter season, water sources are limited and few households that own boreholes tend to sell water for drinking and cooking to those without. Depletion of water in shallow wells forces most households to travel long distances to fetch water for other general domestic uses. Backyard gardening is abandoned due to water shortages. The influence of seasonal variability on social practices, like cooking, laundry, ironing, bathing, gardening, water drinking, heating, refrigeration, and electronic communication demonstrates, to policymakers, the importance of interconnecting WEF resources in addressing household vulnerabilities. It is also imperative to help policymakers in their understanding of the nexus between practice issues, climate change, and WEF vulnerabilities to improve service delivery. This may influence policymakers to design and implement interventions that promote socially sustainable practices that will enable sustainable consumption of resources in households. Examples of possible interventions include investing in infrastructure to improve access to clean water and affordable energy sources, promoting education and awareness about sustainable energy practices and technologies, and implementing policies to support sustainable urban agriculture and backyard gardening practices.

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