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Dynamics of Meteorological Drought and Coping Strategies: A Case of Misima Ward in Handeni District, Tanzania

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Abstract

Various drought assessment frameworks, such as Standardised Precipitation Evapotranspiration Index (SPEI), Standardised Precipitation Index (SPI), Palmer Drought Severity Index (PDSI), SPEI- Integrated Timescale (IT), and standardised soil moisture indices, do exist. However, the World Meteorological Organisation (WMO) advocates that the Standardised Precipitation Index (SPI) is the global standard meteorological drought monitoring technique. It has received little attention over other drought severity analysis techniques, compromising the credibility of information for drought monitoring purposes. This study uses SPI to analyse the frequency, severity, impacts, and adaptation strategies for meteorological droughts on livelihood activities in Misima Ward, Handeni District, Tanzania. Data were collected through document review, questionnaire, focus group discussions, key informant interviews, and physical observations. The study reveals that Handeni experienced meteorological drought events between 1992 and 2022. The moderate drought years were 1993, 1994, 1995, 2003, 2004, 2006, 2007, 2008, 2010, 2012, 2016, and 2020; severe drought years were 2005, 2009, 2019, and 2022; and extreme drought years were 1992, 1996, 1997, 2000, 2009, and 2016. Households employed different coping and adaptation strategies such as selling assets, migration, food aid, looking for an alternative source of income, and reducing food consumption. The study recommends tailored training to age and education groups to enhance the coping and adaptation measures. The study also recommends the need for community-driven adaptation strategies to enhance resilience, including improved water management, livelihood diversification, and policy support.

Keywords: Drought, Coping strategies, Adaptation Strategies, community, drought severity

1.0 Introduction

Drought is one of the most severe climate-related disasters, posing a significant threat to livelihoods, agriculture, and water resources worldwide (Agele, 2021; Ahmad *et al.,* 2022; Mahedi *et al*, 2025). As a recurrent climate phenomenon, drought emerges when precipitation falls below the average for an extended period. This is a common issue in most parts of the world that experience dry, semi-dry, humid, and semi-humid climate conditions (Edith, 2021; IPCC, 2022; Mohamed et al, 2022). While the definitions of drought may vary by area and

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discipline, it typically involves a decrease in the amount of precipitation received over an extended period, typically throughout a season or longer (Han & Singh,2023; Haile, 2020). There is an increasing concern that the frequency and severity of drought will increase in all regions due to climate change (Mukherjee et al., 2018; Spinoni et al., 2015). Furthermore, water resource depletion, land use change, and socio-economic activities have been a cause for drought events. Globally, drought is one of the events that has caused the most human losses, including the death of 650,000 people from 1970 to 2011 (IPCC, 2022; Jahura, 2024; Zhou, 2023), as well as loss in agriculture and livestock, leading to food insecurity and income losses, water insecurity, environmental degradation, and migration. Drought losses might grow five times from current levels if global warming hits 3 degrees Celsius by 2100 (Summerhayes et al., 2025; Cammalleri, 2021).

According to the World Meteorological Organisation (WMO) State of the Climate in Africa 2024 report, East Africa (including northern and coastal regions such as Tanga) continues to experience prolonged dry spells driven by climate variability and change, with drought hotspots persisting in central and northern Tanzania as recently as early 2026. These conditions align with broader continental trends: Africa recorded its hottest or second-hottest year on record in 2024, exacerbating drought frequency and intensity across semi-arid zones.

Drought conditions are more prevalent in Tanzania's northern and central regions, including Arusha, Manyara, Shinyanga, Simiyu, and Dodoma (TMA, 2022; Mramba&Mapunda, 2024). The country experienced severe drought episodes in 1999–2000 and again in 2005, which were associated with widespread impacts such as reduced crop yields, food insecurity, water shortages, and hydroelectric power disruptions (TMA, 2022; Kijazi & Reason, 2009). Over the past decade, similar drought-related challenges have continued to affect livelihoods across various parts of the country.

Although Handeni District is not traditionally classified as a drought-prone area, it has experienced increasingly severe and recurrent drought events over the past decade, significantly affecting local livelihoods (Chingonikaya, 2025). Meteorological data from the Tanzania Meteorological Authority indicate that between 2010 and 2023, the district recorded an approximate 20% decline in average annual rainfall, with particularly severe drought conditions observed in 2012, 2016, and 2021(Luhunga, 2025). These persistent dry spells have contributed to crop failures, reduced pasture availability, and declining water resources, thereby worsening food insecurity and economic vulnerability among communities.

This emerging pattern has generated growing scholarly and policy interest in understanding why Handeni District appears to be experiencing increasing drought risk in recent years despite its historical classification as a less drought-prone area. In the study area, local communities have developed various coping and adaptation mechanisms in response to drought-related challenges. However, despite existing studies in Handeni and other regions, there remains limited empirical evidence on the frequency and severity of drought events in Handeni District, as well as how local communities specifically respond to these events. This study addresses this gap by analysing drought characteristics using the Standardised Precipitation Index (SPI) and examining household-level adaptation strategies in the district. Specifically, the study determines the frequency and severity of drought events from 1992 to 2022 and documents the coping and adaptation strategies employed by households. While the Standardised Precipitation Index (SPI) is a well-established and widely used tool for drought analysis globally, its application in this study is not intended to demonstrate methodological novelty. Rather, the contribution of this research lies in its contextual and integrative application within

Handeni District, Tanzania. In particular, the study combines SPI-derived drought characteristics with household livelihood data to establish linkages between meteorological drought conditions and socio-economic impacts at the community level. In addition, SPI-based drought classifications are compared with local community perceptions, thereby strengthening the interpretation of drought conditions and providing a form of validation in a data-scarce rural context.

2.0 Methodology

2.1 Case study area description

Handeni District is located in the Tanga Region in northeastern Tanzania and covers an area of around 7,534 square kilometres. Handeni is one of the eight districts of the Tanga region in Tanzania, which is bordered to the west by Kilindi District, to the north by Korogwe District, to the east by Pangani District, and to the south by the Pwani Region. The topography is between 600 and 1,200 meters above sea level (Figure 1). Handeni District experiences a tropical savanna climate, where most of the district has high temperatures and humidity, which is typical of a coastal climate. The Handeni District has many types of vegetation, starting from miombo woodlands, which are dominant, to grasslands, coastal forests, riverine vegetation, and scrublands.

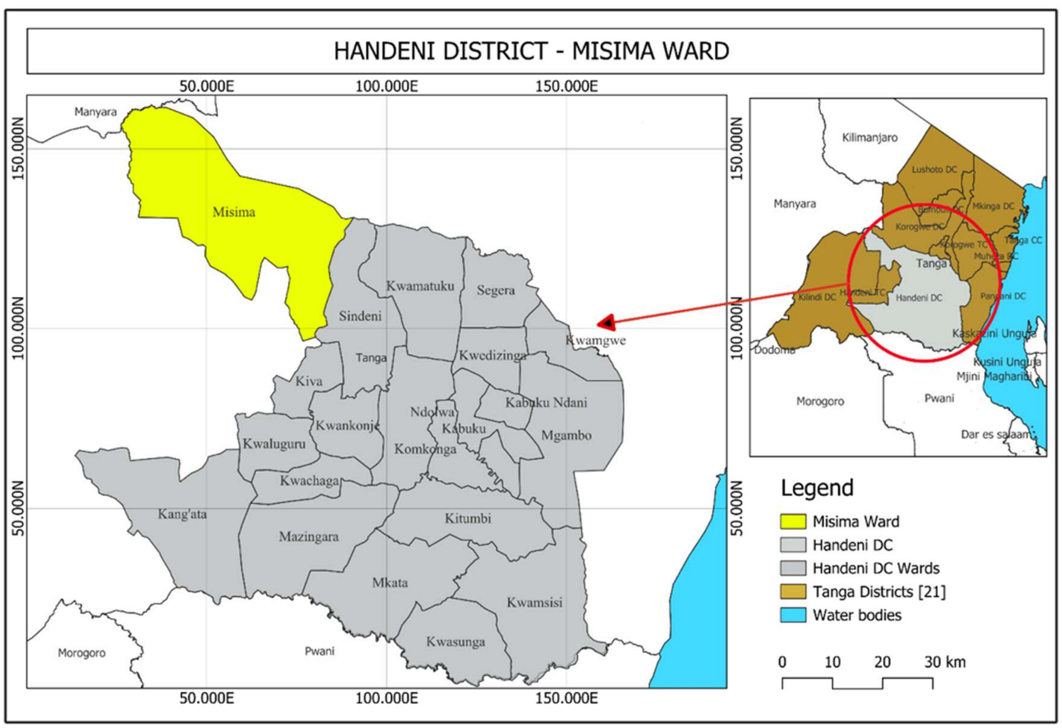

Figure 1: Location of the Study Area

Handeni District is administratively divided into seven divisions, 19 wards, and 112 villages; according to the Tanzania National Census of 2022, 384,353 people live in Handeni District. High frequency of drought events, reliance on agriculture and livestock operations, a variety of coping and adaptation strategies, population density, and socioeconomic diversity were taken into consideration when choosing the representative ward. Because Misima Ward received the highest score out of all the wards, it was chosen as a case study area. Mbagwi, Kibaya, Mzeri, and Msomera are the four villages of the Misima ward. The ward is one of the most drought-affected areas; most residents depend on drought-prone activities like farming and raising livestock; it has a variety of coping strategies and adaptation techniques, making it a rich field for research; and its mix of low-, medium-, and high-income households makes it possible to conduct a thorough analysis of the effects of drought on various socioeconomic groups.

2.2 Sampling procedure

The study adopted a descriptive survey research that blends quantitative and qualitative data to provide a researcher with relevant and accurate information (Aggrawal, 2008). This study employed simple random sampling and purposive sampling techniques to enhance the validity and comprehensiveness of the findings. Purposive sampling was used to get 19 samples of participants for interviews and six (6) participants for focus group discussions. Simple random sampling was employed to select village households to obtain a sample for the questionnaire survey. This study used 160 households that were randomly selected from the Misima ward as the representative sample. The household head was the unit of observation. The sample size was determined by using the formula (1) below, which is derived from statistical principles.

$$n = \left(\frac{Z^2 P(1-P)}{e^2} \times N\right) \div \left((N-1) + \frac{Z^2 P(1-P)}{e^2}\right) \quad (1)$$

whereby
n = sample size,
N=size of targeted population (4582)
e = the desired level of precision (10% = 0.1),
Z = 2.58 at 99% level of confidence,
ρ = 0.5 at 50% proportion of attribution

2.3 Data collection methods

Primary data were collected through a household questionnaire, key informant interviews, focus group discussions, document review, and observation. A total of 160 questionnaires were administered to four (4) villages. Questionnaire surveys were used to acquire data on household characteristics, drought, impacts on livelihood activities influenced by social, economic, and environmental changes, and coping and adaptation measures used by local communities. The questionnaire had both closed and open-ended questions. The closed-ended questions aimed at reducing ambiguity in answers and allowing comparison across respondents. The open-ended questions aimed at obtaining the detailed explanations, opinions, perceptions and experiences. Misima ward has four villages, and proportionate random sampling was used to select household respondents from all four villages, as shown in Table 1.

Table 1*: Study population and Sample size distribution per village of the Misima ward*

N/a	Village	Households	Percentage	Sample size
1	Mzeri	1244	27	45
2	Mbagi	930	20	33
3	Kibaya	712	16	26
4	Msomera	1696	37	56
	Total	**4582**	**100**	**160**

A semi-structured interview was used to ensure flexibility while all key topics were covered. Nineteen (19) Key informant interviews were conducted with the district disaster risk management coordinator, Agricultural Extension Officer, and community leaders, including elders in all four (4) villages. Direct observation of the environment and socio-economic activities was done to gain insights into drought impacts and households' coping and adaptation measures.

Focus Group Discussions (FGDs) involved six (6) participants selected purposively and systematically from households within the study area. The selection aimed to ensure that participants were relevant, diverse, and knowledgeable about local drought conditions and livelihood experiences. Gender considerations were incorporated to ensure balanced representation of both men and women within the group. The selection criteria combined purposive sampling based on relevance and experience with maximum variation in gender, livelihood activities, and socio-economic status, thereby enhancing the richness, balance, and credibility of the qualitative data collected.

In addition, secondary data were obtained from both published and unpublished sources relating to the Handeni communities and drought-related studies. Meteorological data were acquired from the Tanzania Meteorological Authority (TMA), specifically from the Handeni station, to support the analysis of rainfall patterns and drought trends in the study area.

2.4 Data analysis

In this study, both qualitative data and quantitative data were analysed. Content analysis was employed to analyse qualitative data from document review, and descriptive analysis was employed for quantitative data collected through the questionnaire. Software packages that include IBM Statistical Package for Social Science A (SPSS) version 21 and Excel were used to statistically analyse quantitative data from questionnaire surveys. Qualitative data acquired through interviews with key informants were organised, cleaned, and interpreted on the grounds of drought impacts, awareness, and coping measures. The precipitation data were analysed using the R-Studio software.

2.5 Determination of Drought Severity

Drought Severity Index (DSI), Standardised Precipitation Evapotranspiration Index (SPEI), and Reconnaissance Drought Index (RDI) were thought to be used in this study; however, the Standard Precipitation Index (SPI) was found to be better due to minimal data requirement, simplicity to analyse drought severity, multi-timescale flexibility, and sensitivity to short-term changes. The SPI was used to measure the precipitation deficit over a range of periods, which might indicate how a drought may affect the availability of various water resources (McKee et al. 1995). Precipitation data for the Handeni meteorological station with a monthly resolution for SPI value calculation from 1992 to 2022 were acquired from the Tanzania Meteorological Agency (TMA). In this study, the 3,6,12 and 24 months SPIs were used. The precipitation data were typically fitted to a Gamma distribution using the Gamma probability density function given by equation (2):

$$g(x) = \frac{x^{\alpha-1} e^{-x/\beta}}{\beta^{\alpha}\Gamma(\alpha)} \quad \text{..} \quad (2)$$

whereby:
x = precipitation amount
α = shape parameter
β = scale parameter

Γ(α) = gamma function
The maximum likelihood estimation method was used to estimate the parameters α and β (equations (3 &4))

$$\alpha = \frac{1}{4A}\left(1 + \sqrt{1 + \frac{4A}{3}}\right) \quad \ldots\ldots (3)$$

$$\beta = \frac{\overline{x}}{\beta} \quad \ldots\ldots (4)$$

where:
$\overline{x}$= mean precipitation
A= ln ($\overline{x}$) $-\frac{1}{n}\sum$ln(x)

Since the Gamma function was undefined for x=0, a mixed distribution with an exponential function for zero precipitation was incorporated. Thus, the cumulative probability function was indicated in equation (5):

$H(x) = q + (1-q)G(x)$	………………………………………	(5)

where q is the probability of zero precipitation.

The cumulative probability H(x) was transformed into a standard normal distribution. The SPI value was computed using equation (6)

$$SPI = \frac{X-\overline{X}}{\sigma} \quad \ldots\ldots (6)$$

Where
XX = observed precipitation
$\overline{X}$ = mean precipitation
σ = standard deviation

The study adopted the Standardised Precipitation Index (SPI) classification developed by McKee et al. (1995). SPI values were categorized as follows: ≥ 2.00 (extremely wet), 1.50 to 1.99 (very wet), 1.00 to 1.49 (moderately wet), 0.00 to 0.99 (mildly wet), 0.00 to -0.99 (mild drought), -1.00 to -1.49 (moderate drought), -1.50 to -1.99 (severe drought), and ≤ -2.00 (extreme drought).

3.0 Results and Discussion

3.1 Household's profile at Misima Ward

The majority (83.1%) of the households' heads were men (Table 1). In the study area, traditionally, men are more responsible for decision-making and resource allocation than women. This implies that men are the key determinant in coping with and adapting to the impacts of climate change at the household level. The age of the respondents varied from 18 to 60 and above, with most respondents from the 31 to 45 group. According to Garcia and Patel (2023), age determines adaptation capacity. Understanding the age of the respondent determines their drought experiences, influences coping and adaptation measures, and therefore is one of the essential variables. Having the majority of young household heads suggests that the community has high adaptive capacity due to their economic activity, physical ability, and openness to training and innovation. Primary education is the most common (50%) level attained among household heads, while 6.8% have no formal education. Study's findings reveal that education has been found to help community members with information on drought adaptation strategies (Belay et al., 2017; Habiba et al., 2014). The level of education among households may limit the understanding of adaptation strategies. The occupational distribution indicates that crop cultivation (42.5%) and livestock keeping constitute the primary livelihood activities in Handeni District, both of which are highly sensitive to climate variability and change. This dependence increases household vulnerability to droughts and erratic rainfall. However, the presence of small-scale businesses (25%) reflects a degree of livelihood diversification, which can enhance coping capacity and resilience, although such activities remain indirectly affected by climate-induced economic shocks.

Table. 1: Household profile at Misima ward in Handeni District

Variables	Frequency	Percentage
Gender		
Female	27	16.9
Male	133	83.1
Age		
18-30	44	27.5
31-45	79	49.4
46-60	32	20
60-More	5	3.1
Education		
No Formal Education	11	6.9
Primary Education	80	50
Secondary Education	62	38.8
Higher Education	7	4.3
Occupation		
Agriculture	68	42.5
Carpenter	1	0.6
Livestock Keeping	42	26.3
Mason	4	2.5
Small business	40	25
Teacher	5	3.1

3.2 The duration and intensity of dry spells at Misima ward in Handeni District

According to the 3, 6, 12, and 24-month SPI timescales, areas experiencing drought in the Handeni District are categorised into moderate, severe, and extreme drought. The analysis confirms that the Handeni District experienced 19 years of moderate to extreme drought within the 30-year study period, highlighting its vulnerability to recurring dry spells. The SP-I3 values for Handeni station revealed a substantial rainfall deficit over three months, starting in November 1996 and persisting through January and February 1997 (Figure 2). Between 30 years of study, Handeni experienced extreme wetness in 1997 from November to December, which was caused by *El Nino* (Gellejah, 2000), and this is the most extreme rainfall recorded over the study period, other extremely wet years were 1998 from April to June which was *Masika rain*, 1999 from July to September which was *Mvuli rain*, 2000, from July to August 2002 only in August, and during 2019 from November to December. Therefore, the three-month analysis of SPI shows high variability in rainfall between the Masika and Mvuli seasons.

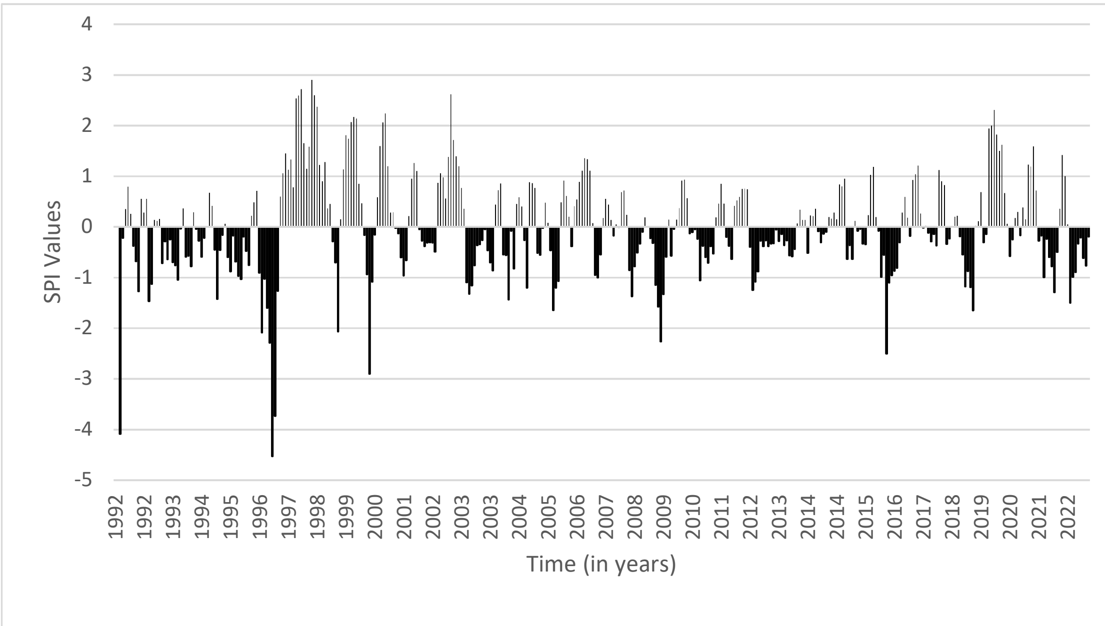

Figure 2: Standardised Precipitation Index for 3 Months for Handeni Station

The SPI-6 analysis revealed recurrent moderate droughts, particularly in the early 1990s and sporadically in later years. Notable moderate droughts occurred in 1992, 1993, 1994, 1995, 1996, 1997, 2000, 2003, 2004, 2005, 2006, 2007, 2009, 2010, 2012, 2016, 2019, and 2021. Severe droughts were observed in 1996, 2005, 2009, 2019, and 2022, while extreme droughts occurred in 1996, 2005, 2009, 2019, and 2022. The most extreme wet period was recorded in April 1998, with other significant wet events occurring in 1998, 1999, 2000, and 2016 (Figure 3).

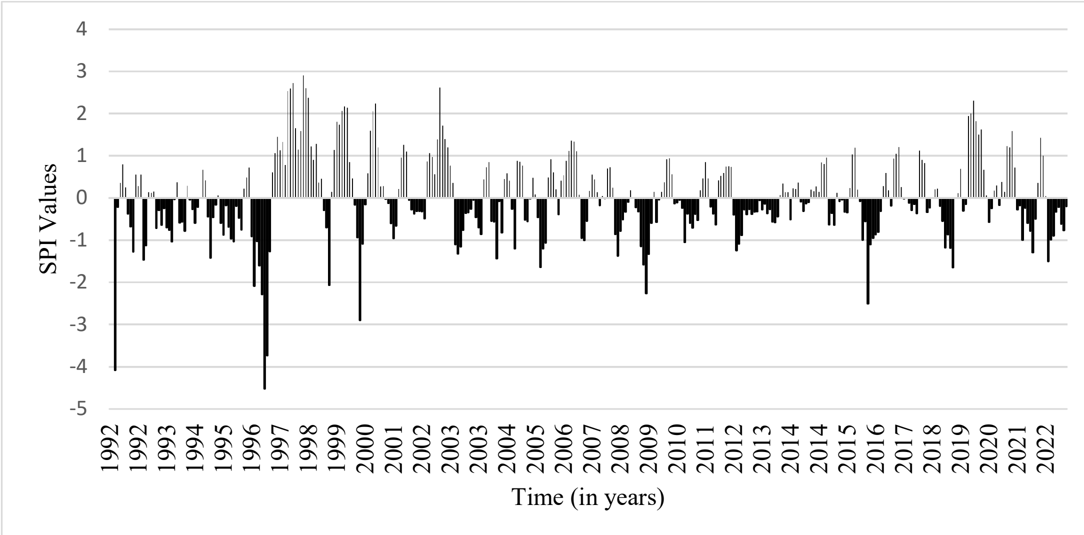

Figure 3: Standardised Precipitation Index for 6 Months for Handeni Station

Similar to the analysis of SPI-6, SPI-12 shows that the Handeni District experienced several years of moderate droughts between 1992 and 2021, highlighting the region's ongoing difficulties. Moderate droughts occurred in 1992, 1993, 1994, 1995, 1996, and 1997, indicating a protracted period of inadequate rainfall in the early 1990s. Moderate droughts occurred in 2000, 2003, 2004, 2005, 2006, 2007, 2009, 2010, 2012, 2016, 2019, and 2021. This pattern shows that there are persistent drought conditions, which are more damaging than single-year events. In contrast to the more frequent moderate droughts, severe droughts were less common but more impactful when they occurred. 1996, 2005, 2009, 2019, and 2022 stand out as periods of severe drought. The trend shows high climate variability, which disrupts farming calendars and increases uncertainty. The severe droughts of 1996 and 2005 were particularly notable, as they were preceded by or followed by periods of moderate drought, compounding their effects. The most severe drought conditions, classified as extreme droughts, were observed within the study period for several years. For example, extreme droughts occurred in 1992, 1996, 1997, 1999, 2009, and 2016. These extreme drought events were characterised by deficient rainfall, leading to critical water shortages. An extreme drought that began in 1992 signaled the start of the study period and set the bar high for the years that followed. The exceptionally severe droughts that occurred in 1996 and 1997 highlighted a run of years with unseasonably high temperatures. Similar severe droughts occurred in 2009 and 2016, which probably significantly impacted the area (Figure 4).

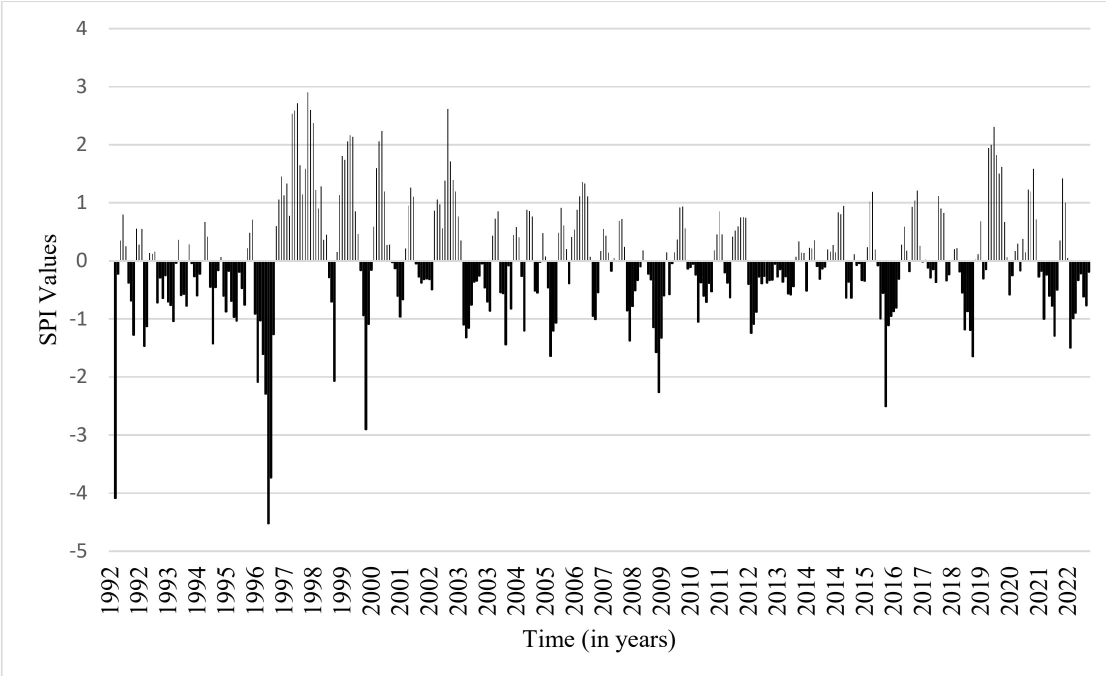

Figure 4: Standardised Precipitation Index for 12 Months for Handeni Station

The observed similarities and differences between SPI-12 and SPI-24 drought patterns can be attributed to the effects of temporal aggregation, where SPI-24 captures cumulative rainfall deficits over extended periods, smoothing short-term variability observed in SPI-12. While SPI-12 reflects inter-annual fluctuations and isolated drought events, SPI-24 highlights persistent multi-year drought conditions influenced by consecutive rainfall deficits, delayed hydrological recovery, and large-scale climate drivers such as the El Niño–Southern Oscillation. Consequently, SPI-24 provides a more robust indication of long-term water stress, whereas SPI-12 is more sensitive to short-term climatic variability. From 1992 to 2021, Handeni experienced numerous moderate droughts, indicating recurring challenges in water availability. The years 1992, 1993, 1994, 1995, 1996, 1997, 2000, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2012, 2016, 2019, and 2021 were marked by moderate droughts.

The SPI-24 analysis shows an even broader distribution of moderate drought years compared to the SPI-12 analysis, highlighting extended periods of below-average rainfall. Severe droughts identified by the SPI-24 analysis occurred in 1996, 2005, 2009, 2019, and 2022. These years align closely with those identified by the SPI-12 analysis, emphasising the significant and recurring nature of severe drought conditions during these periods. The consistency in severe drought years across both SPI-12 and SPI-24 analyses underscores these droughts and their widespread impact on the region. The SPI-24 analysis identified extreme droughts in 1992, 1996, 1997, 1999, 2000, 2009, and 2016 that were characterised by severe critical water shortages. With the year 2000 included, these years roughly correspond to the exceptional drought years determined by the SPI-12 analysis. The extreme drought years largely overlap, with SPI-24 adding 2000 as an additional extreme drought year (Figure 5).

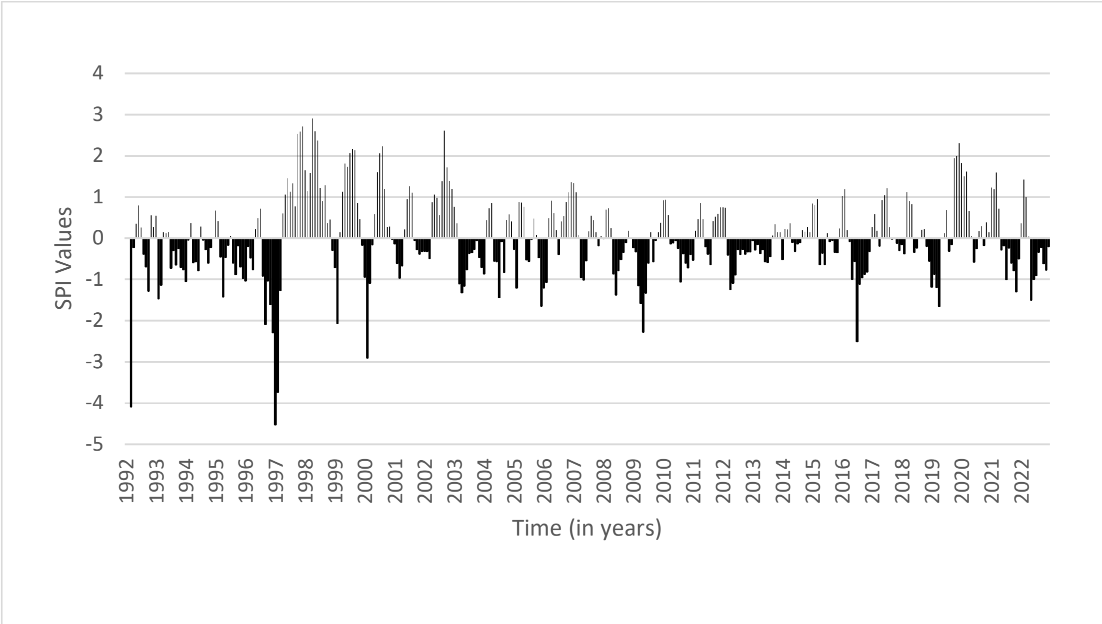

Figure 5: Standardised Precipitation Index for 24 Months for Handeni Station

3.3 Drought coping strategies

Households constituting the Misima Ward community employ various coping strategies, ranging from selling assets, reducing food consumption, migration, and reducing farm size and livestock. The most used strategies are selling assets, followed by the reduction of food consumption and securing aid (Figure 6).

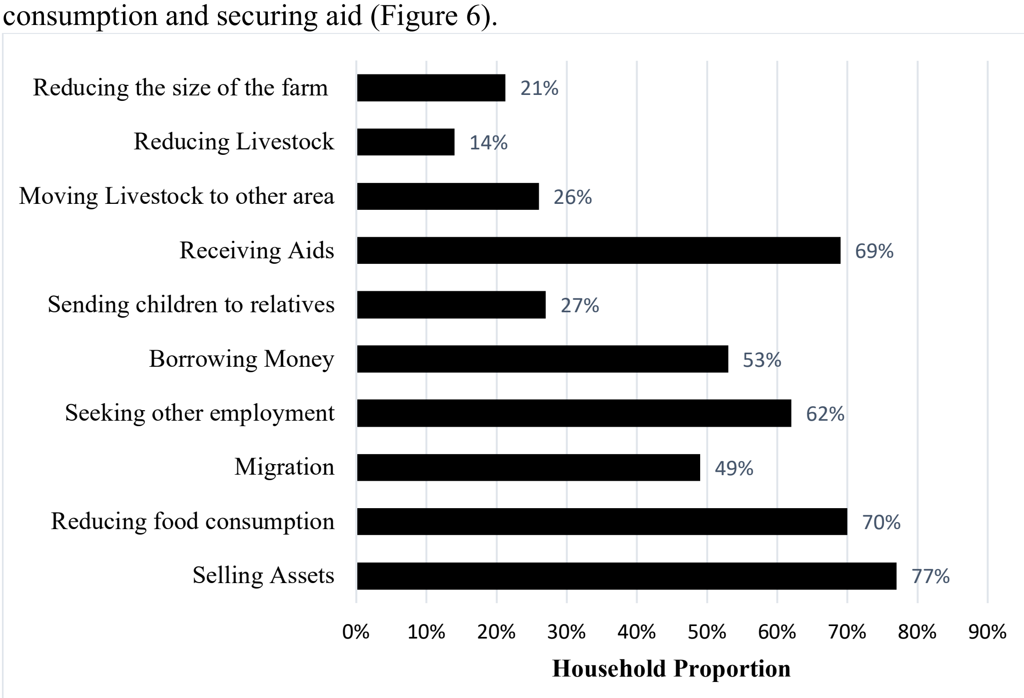

Figure 6: Existing coping measures for addressing the impacts of drought in the Handeni district

3.3.1 Selling assets

The results indicate that this is a common coping strategy, reported by 77% (n=123) of households. Tangible assets such as livestock, surplus crops, motorcycles, and household goods were frequently sold. This reliance on assets for survival can deplete resources and increase vulnerability. Previous research has shown similar patterns in semi-arid regions, where asset depletion leads to prolonged economic hardships (El Kenawy, 2024).

3.3.2 Migration

Forty-nine per cent (49%) of households, mainly Maasai pastoralists, were moving from Handeni to Simanjoro, Arusha, in search of pasture and water. It was reported that pastoralists migrate to areas such as Arusha in search of pasture and water. Migration was said to disrupt family structures, especially among pastoralist communities, as men leave while women and children remain behind, facing challenges in accessing food and other essential needs. During the focus group discussion, it was further reported that Maasai women are not allowed to participate in decision-making regarding family matters. However, this strategy helps prevent disease transmission among livestock (Ndikumana et al., 2000). Studies by Homewood and Rodgers (1991) also indicate that mobility avoids the concentration of a large number of animals that may accelerate environmental degradation.

3.3.3 Food aid

About 69%= (n=110) of households received food aid, mainly maize grain from the government. The affected households (110) received about 5 to 10 kg of maize grain from the government. While the aid was intended to prevent food insecurity and asset loss, respondents noted that it was not delivered promptly and was insufficient. One of the household's head had this to say: "…. *although the aid was intended to prevent food insecurity and asset loss, it was not delivered promptly and, even when it arrived, it was insufficient to meet the needs of affected households*….". Similar findings have been reported in drought-prone areas of East Africa, where delays in aid distribution limit its effectiveness in preventing food insecurity (Ndikumana et al., 2000).

3.3.4 Alternative Sources of Income (ASI)

The results show that 62% (n=99) went to find jobs other than their primary job to supplement their income, including petty business during the drought. However, studies on rural livelihood transitions have noted that some weren't able to get alternative jobs because of the few available options (Musumba et al., 2022).

3.3.5 Reducing food consumption

Seventy per cent of households reduced consumption, skipped meals, or decreased the portion of food. 70% (n=112) of the population used this strategy, and some reported skipping meals, a day passed without eating, and some reported reducing the quantity. This reflects the limited resources of people in Handeni. This strategy worsens malnutrition, especially among children and the elderly, as documented in studies on food security in Tanzania (Kejo et al., 2018).

3.3.6 Borrowing money

The profound impacts of drought on local communities' livelihoods increase the poverty level. Borrowing money was the strategy used by 55% (n=88) of the households. Thus, the strategy provides relief, although it can drag people into long-term debt that may affect their economic sustainability in the future, as noted by Ellis and Freeman (2004).

3.3.7 Farm size and livestock reduction

Farm size reduction was used by 21% (n=34) of respondents to cope with drought, often by shifting to drought-resistant crops. While this may help in the short term, it lowers agricultural productivity and food security. Similarly, 14% (n=22) of respondents reduced herd size to cope with drought impacts, including reduced pasture and water. However, selling livestock affects economic stability, particularly for communities like the Maasai, where livestock is central to livelihood and social status (Ndikumana et al., 2000; Homewood & Rodgers, 1991).

3.4 Adaptation measures used in the Misima ward against drought

Adaptation strategies such as diversification of income sources and water conservation practices have been adopted; however, their sustainability is constrained by financial and technical limitations. The most adopted adaptation measures by the majority of households (63%) are on diversification of income sources, followed by planting early maturity maize varieties and serving schemes (Table 2).

Table 2: Adaptation measures used in the Misima against Drought (n=160)

Adaptation Strategy	Frequency	Percentage
Drought-resistant crop	61	38%
Rainwater harvesting	28	18%
Livestock management practices	63	39%
Serving Schemes	86	53%
Livestock Mobility	25	15%
Crop Diversification	16	10%
Improved Agriculture	19	12%
Digging stock ponds	5	3%
Remittance	15	9%
Diversifying income sources	102	63%
Early maturity maize Varieties	92	58%

3.4.1 Diversifying Income Sources

Diversifying income sources from agriculture is one of the adaptations used in Misima. Respondents who claimed to diversify income sources accounted for 63%. Respondents reported diversifying agriculture and livestock activities as the primary source of income by engaging in various economic activities like petty businesses and casual labour as alternative livelihoods. However, some respondents claimed that casual labour did not work out as expected due to the availability of only low-paying jobs. These results confirm the study by Vernooy (2022), which revealed that 83% of the farmers diversified agriculture as an adaptation strategy. However, the findings show that it was not significant in supporting smallholder farmers' well-being. This contradicts the Intergovernmental Panel on Climate Change (IPCC) (2022), which argues that diversification improves economic resilience by reducing reliance on sectors sensitive to climate change.

3.4.2 Livestock Mobility

Livestock was also reported as the adaptation strategy; 15% of the sample population used it. During the dry period or at the end of the dry period, the area experiences high mobility, searching for pastures and water. During a focus group discussion, it was reported that this strategy helps livestock herders avoid diseases by avoiding the known areas and providing them with the assurance of pasture in the receiving area. However, the risks of moving weakened livestock increase the loss due to the long time it takes to reach a destination.

3.4.3 Serving Schemes

About 53% (n=85) of the respondents use the serving schemes available in their villages to adapt to drought. There are different SACCOS groups in their villages owned by the community that help people cultivate the culture of serving and offer the chance to get loans without having loan collateral. Retnoningsih & Chung (2025) argue that climate change and variability exacerbate uncertainties and, consequently, risk aversion, which increases vulnerability and exposure to profound impacts of climate change incidents like drought. Social protection, like serving schemes in rural households, has proven to be effective in addressing the challenges the poor and most vulnerable people encounter when attempting to build up their resilience.

3.4.4 Remittance

Nine per cent (n=14) reported benefiting from the Tanzania Social Action Fund (TASAF) program. This program, established in 2000 as part of the government's initiatives to reduce poverty in different phases, provides money monthly to poor households to support their well-being. However, some TASAF beneficiary households have been receiving remittances, particularly local or domestic remittances from their household members.

3.4.5 Crop Diversification

The results of this study show that crop diversification was practised by 10% (n=16) of respondents to cope with drought. Planting many crops on the same farm field or different farms is an effective strategy that avoids total loss in a period of drought since different crops have different maturity times, drought resistance, and reliance capacity (Makate et al., 2018). During focus group discussions, respondents reported planting maize, beans, cassava, sweet potatoes, sunflowers, and oranges. However, statistically, crop diversification was not an effective strategy for a more significant proportion of the respondents due to the prolonged dry period that affected crop production, depending on different tolerance capacities and inappropriate family practices. This is supported by Vernooy (2022), who asserted that prolonged droughts affected productivity, limiting the effectiveness of this strategy.

3.4.6 Drought resistance-crops

The results show that 38% (n=61) of the respondents adopted planting drought-resistant crops to combat drought. These crops require less water and can withstand dry conditions, guaranteeing harvest even when rainfall fails. During focus group discussions and key informant interviews, it was revealed that some small farmers planted cassava, sweet potatoes, sunflowers, and millet, and explained to respondents that these crops could sustain drought. The results align with Mligo et al. (2022), who reported that small-scale farmers frequently grow drought-resistant crops against climate change and variability in the Mvumuro District, Tanzania. Also, Fisher et al. (2015) revealed that farmers in sub-Saharan African countries planted drought-tolerant maize varieties in response to climate variability and change. However, it was revealed that during planting season, millet prices increase, and some small-scale farmers cannot afford to buy seeds. This makes them wait until the price is down; therefore, they plant late, which does not affect their production significantly.

3.4.7 Livestock Management Practices

Thirty-nine per cent of the respondents reported using only vaccination and rotating grazing areas as livestock management practices during drought periods. No one reported using supplements together with forage to ensure a balanced diet, regular veterinary check-ups, or managing animal breeding to improve genetic quality.

3.4.8 Improved Agricultural Practices.

Twelve per cent (n=19) reported planting in rows and using fertilisers. This technique aims to increase agricultural production. Respondents revealed that they started sowing maize seeds in rows and with enough space between one maize to another. Lenga et al (2024) argued that when crops are established in rows, inputs (such as compost) can be used more effectively since they can be spread across the entire field instead of being placed alongside seeds or in holes with seedlings. However, during the study, it was revealed that farmers avoid the use of chemical fertilisers despite the efforts of the government to subsidise these fertilisers, believing that they can harm and deplete the soil quality.

3.4.9 Planting Early Maturity Crop Varieties

Early-maturing cultivars of maize offer less competition for light, moisture, and nutrients than late-maturing types, making them perfect for intercropping. 58% (n=93) of the respondents adopted this strategy. These results align with those of Mligo et al. (2022), who found that farmers in Mvumero planted early-maturity varieties to adapt to climate variability and change and improve food security. Similar findings by Bello et al. (2012) revealed that most farmers in Nigeria adopted early-maturity varieties in a changing climate.

3.4.10 Digging Livestock Ponds

Digging stock ponds was the least common strategy, adopted by only 3% (n=5) of respondents, as it has cost implications. Though these ponds provide water during drought, their effectiveness is limited by evaporation and seepage. It was observed that the ponds in Misima are shallow and easily lose water during dry periods. Bedell (1992) argued that if you build ponds, ensure they are relatively deep, then fence them and provide a livestock walkway to reduce water loss and improve drinking water quality.

4.0 Conclusion and Recommendation

The study aimed at assessing the meteorological drought using the precipitation Index (SPI), which was found suitable due to minimal data requirements and multi-timescale flexibility, adding credibility of information for drought monitoring purposes. Between 1992 and 2022, Handeni District had regular and recurrent meteorological droughts, indicating a continuous and growing climate-related risk. Particularly for communities reliant on rain-fed agriculture and pastoralism, these drought occurrences have had severe detrimental effects on local livelihoods, including widespread income loss, food insecurity, water shortages, and livestock fatalities. Despite these difficulties, the majority of households rely on short-term coping mechanisms that only offer short-term respite and do not improve long-term resilience, and the adoption of sustainable adaptation techniques is still low and has to be strengthened. Promoting climate-smart agriculture through the use of drought-resistant crops, early-maturing cultivars, and better farming techniques is necessary to increase Handeni District's resilience to drought. To solve ongoing water scarcity, it is also critical to improve the management of water resources, especially through investments in rainwater collection, small-scale irrigation, and sustainable water storage systems. Additionally, communities will be better equipped to anticipate and respond to drought crises if livelihood diversification is encouraged and access to early warning systems and trustworthy climatic information is improved.

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