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# GREEN RESILIENCE: THE ROLE OF WOMEN ENTREPRENEURS IN DRIVING CLIMATE-ADAPTIVE MICRO-ENTERPRISES IN COASTAL KERALA

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***Abstract***

*Climate change poses new challenges to micro-enterprises operating in coastal regions of developing countries. Micro-enterprises in these areas therefore need to adapt and become climate-resilient. This is particularly challenging for women entrepreneurs who often possess limited resources. This study explore the role of women entrepreneurs on enhancing green entrepreneurial resilience in climate adaptive micro-enterprises. We focus on micro-enterprises in coastal Kerala, India. Dynamic capability and sustainability-oriented entrepreneurship perspectives form the basis of this research. A structured questionnaire has been used to collect data from 435 women entrepreneurs who are engaged in fisheries, coir, food processing, and tourism industries. The analysis was done using structural equation modeling (SEM).*

*External factors affecting firm-level resilience get transformed into resilience outcomes through adaptive capability. Climate risk and resource availability enhance adaptive capability to a great extent, which in turn has significant impact on green innovation and green entrepreneurial resilience. Institutional support is crucial for enhancing green innovation but has no direct effect on resilience. However, green innovation does have a significant positive effect on resilience. Moreover, green entrepreneurial resilience has positive effect on business performance, indicating its strategic relevance. This study offers a unique contribution to the business and management literature by addressing the gap that currently exists within the green entrepreneurship field by developing a concept – green entrepreneurial resilience – which merges insights from the fields of gender, climate adaptation and micro-entrepreneurship. By drawing on narratives of women entrepreneurs in coastal Kerala, the study demonstrates how women have the potential to transform what could be seen as mere 'vulnerability' into sustainable business opportunities. Importantly, the study has emergent theoretical and practical implications for building capability-based support systems for enhanced climate resilience and for fostering sustainable development.*

***Keywords:Entrepreneurial Resilience;Women Entrepreneurs; Climate Adaptation; Adaptive Capability; Green Innovation; Micro-Enterprises; Institutional Support; Business Performance.***

## Introduction

Natural resources are threatened by climate change, especially in developing economies, the coastal districts could reap rewards by pioneering environmental entrepreneurship. In the coastal districts of Kerala, climate-related environmental disturbances such as occasional flooding, erosion and increased salinity have added to the trauma of economic instabilities and affected lives by disturbing major economic activities and livelihood systems (Brush et al., 2022). Small economic actors get affected most because of limited resources, while women entrepreneurs in the region have become critical in building economic resilience (Alsos et al., 2013). Many micro-enterprises, running in the region and either generating employment or producing and distributing goods and services for market, have women as

pivotal actors. The trend of women entrepreneurs is increasing in the districts, particularly when engaged in fisheries-based, coir, food processing and tourism enterprises (Sivaraman&Neriamparampil, 2024). While many women have become entrepreneurs out of necessity and requirement, some are entrepreneurship-bound by opportunity and prospects. Kerala's women entrepreneurs are adapting to the challenge of climate change by discovering new opportunities that are critical to strengthening environmental entrepreneurship in their communities (Unnikrishnan&Mohanadasan, 2025).Despite progress in addressing climate change, there is a significant disconnect between prevailing ways of talking about climate change policy at the macro-level, and the everyday realities of entrepreneurs at the micro-level (Brush et al., 2019). While existing policies for enhancing climate resilience and sustainable development rarely incorporate the perspectives of grassroots entrepreneurs, especially women this segment of society is increasingly engaged in enterprise to strengthen their livelihoods (Machado et al., 2023). Women-led micro-enterprises are emerging as vital stakeholders in addressing environmental crises. The research has treated women entrepreneurship in less industrialized regions to empowerment, financial independence, and community development, this research considers women entrepreneurs as active agents who are already evolving innovative practices that successfully foster adaptation and resilience (Krishnapriya&Ajithkumar, 2025). Integration of the entrepreneurship field with theories and models of climate change adaptation and resilience has the potential to greatly advance research and policy on sustainable enterprise (Huang et al., 2022).

There is a notable absence of research that systematically examines the ecosystems of micro-enterprises in vulnerable regions, especially in coastal regions of less industrialized economies (Tripathi, 2023). Micro-enterprises may be small in scale, but they are large in significance as they support and sustain livelihoods in areas affected by climate change.

Existing studies on women entrepreneurship have concentrated primarily on issues of financial access and empowerment outcomes, and social barriers to women's entrepreneurial pursuit. These issues, while critical, do not capture the full spectrum of challenges women face as entrepreneurs in environmentally vulnerable regions(Kanze et al., 2018). Notably absent from the literature are studies that systematically analyze the climate-adaptive strategies women employ within their enterprises, and how these strategies influence business sustainability and growth(Bendell et al., 2019). Moreover, there is a need to better understand the role women entrepreneurs play as agents of environmental innovation and resilience building. While there are frameworks that attempt to capture the potential of women-led enterprises to generate adaptive solutions in the face of increasing uncertainty and change, these remain underdeveloped(Dai et al., 2019). This study therefore introduces the concept of "Green Entrepreneurial Resilience" as an integrated framework for analyzing the nexus of gender, entrepreneurship, and climate change. The study also contributes to the emerging market literature on small businesses in coastal regions by providing context-specific insights into the ecosystem of micro-enterprises in Kerala, and by problematizing the typical depiction of women entrepreneurs as vulnerable actors. Instead, this study uncovers women entrepreneurs as proactive agents of resilience and innovation, driving the creation of climate-adaptive micro-enterprises and generating green entrepreneurial resilience. The primary objective of this study is to examine how women entrepreneurs in Kerala pursue climate-adaptive micro-enterprises, utilizing resources, capabilities, and institutional support to build green entrepreneurial resilience and sustain their businesses.

**Review of Literature**

Women entrepreneurship, sustainability and climate resilience, particularly in emerging economies, have been drawing the attention of scholars and practitioners in recent years. While a large number of

studies have investigated women entrepreneurship through the lenses of structural and socio-cultural barriers to entrepreneurship, such as gender gaps in access to finance, physical mobility, business support institutions, and gender stereotypes about appropriate roles for women and men (Safarov, 2021; Bai&Chandrasekar, 2022), have treated women entrepreneurship challenges within a multi-dimensional framework of money, market, management, motherhood, and macro environment (Thamizhvel &Shambu, 2023). Although these studies have portrayed women as potential entrepreneurs in spite of various barriers to and challenges of entrepreneurship, recently, they have started to depict women as entrepreneurs and innovators and agents of change within environmental contexts (Suseno& Abbott, 2021). The increasing importance of sustainability in current business practices and environment has opened the avenue for a recent stream of research on women's sustainable entrepreneurship (Kelly &McAdam, 2023), women are more social responsible than men and therefore tend to be more oriented towards environmental and sustainable development objectives in designing and managing their businesses, global studies have found that women's awareness and values towards sustainable practices determine the extent to which women integrate sustainable practices into their businesses (Tripathi, 2023). The most recent studies apply behavioral determinants of sustainable entrepreneurship such as self-efficacy, attitude, and entrepreneurial innovation to explain how women entrepreneurs leverage limited resources to achieve sustainability (Raj Kumar et al., 2026).

The immense vulnerability of micro-enterprises in developing economies highlighted in climate studies; however, the entrepreneurship research focused on female entrepreneurship in developing economies(Marvel et al., 2015). Female entrepreneurs are often found to operate in sectors that are sensitive to climate change such as agriculture and fishing. Due to the inherent gendered nature of societal and institutional environments, female entrepreneurs are further handicapped in accessing critical resources, technology and information needed for climate change adaptation (MS & Jose, 2025). Despite wide recognition of vulnerabilities facing entrepreneurs, the prevailing research often reflects a deficit-oriented perspective that highlights barriers and handicaps rather than fostering an understanding of entrepreneurial capabilities (Ameen et al., 2023). Resilience has emerged as a significant concept within entrepreneurship research, especially in the context of crises such as climate change and the recent global health disaster. Resilience is increasingly regarded as a process of adaptation, recovery and transformation rather than fixed trait (Bai&Chandrasekar, 2022). While general evidence from developed and emerging economies highlights the role of social networks, institutional support and psychological factors, such as hope, in enhancing entrepreneurial resilience, a gap in the literature exists regarding in-depth explanations of how resilience functions within climate-adaptive entrepreneurial contexts (Kang, 2022; Hammad&Naggar, 2023). Many programs and initiatives have empowered women entrepreneurs through capacity building and collective action in regions of the world considered less than ideal for entrepreneurship, due to the poor implementation or lack of alignment with local realities (Orobia et al., 2020).

The existing body of literature provides relevant knowledge to the research on women entrepreneurship, sustainability and resilience in combine (Abed, 2021; Arroyo, 2020; Ge et al., 2022), there still remain gaps in the current study both in terms of empirical and theoretical. Most research tends to focus in specific areas rather than being integrated, especially in the context of micro-enterprises. This study attempts to bridge that gap by highlighting the importance of 'Green Entrepreneurial Resilience', measured in terms of climate risk perception and response, through critical examination of women entrepreneurs in micro-enterprises using a case study in climate vulnerable coastal district of Kerala.

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The study seeks to make a contribution by building contextual knowledge as well as by theorizing and highlighting the potential of micro-enterprises in climate adaptation and sustainable development.

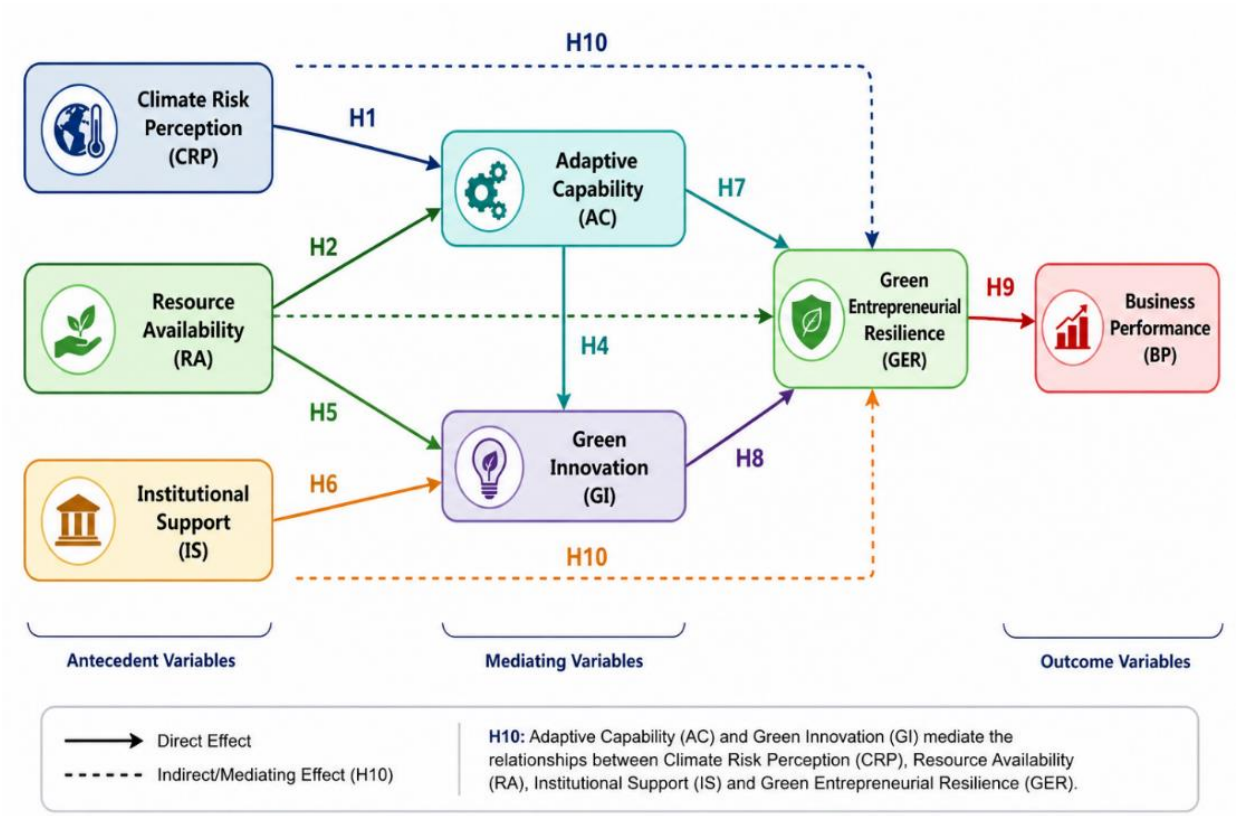


**Figure 1: Hypothesized Model**

## Methodology

This study examines the determinants of green entrepreneurial resilience among women entrepreneurs in coastal Kerala using a cross-sectional research design. The study is explanatory in nature as it tests a number of theoretical relationships between a set of constructs that are drawn from dynamic capability and sustainability-oriented entrepreneurship. A survey methodology was adopted to perceptions of women entrepreneurs with respect to climate risk, resources, institutional support, adaptive capability, green innovation, entrepreneurial resilience and business performance (Figue 1). The study focuses on women entrepreneurs with micro-enterprises in a variety of climate-sensitive sectors such as fisheries, coir, food processing and tourism in the coastal districts of Kerala. A stratified random sampling technique is used to confirm a sample that is suitable for contrasting and generalizing across sectors and enterprise types. A sampling frame of women entrepreneurs was created using local sources of entrepreneurship development and community contacts. A structured questionnaire was used to collect primary data from which valid responses were obtained from 435 women entrepreneurs. Structural equation modeling is employed to test the hypothesized relationships among the study variables using the responses obtained from the study sample.

**Results:** The descriptive analyses of demographic characteristicsprovides contextual insights of women-led micro-enterprises in coastal Kerala.

**Table 1: Socio-Demographic Profile of Respondents (N = 435)**

| Variable | Category | Frequency (n) | Percentage (%) | Mean | SD |
|---|---|---|---|---|---|
| **Age** | Below 25 Years | 50 | 11.5 | 2.85 | 1.008 |
| | 25–34 Years | 109 | 25.1 | | |
| | 35–44 Years | 134 | 30.8 | | |
| | 45–55 Years | 142 | 32.6 | | |
| **Educational Level** | School Level | 88 | 20.2 | 3.07 | 1.482 |
| | Diploma | 90 | 20.7 | | |
| | Undergraduate | 68 | 15.6 | | |
| | Postgraduate | 81 | 18.6 | | |
| | Others | 108 | 24.8 | | |
| **Marital Status** | Single | 141 | 32.4 | 2.01 | 0.812 |
| | Married | 149 | 34.3 | | |
| | Others | 145 | 33.3 | | |
| **Business Type** | Fisheries | 109 | 25.1 | 2.55 | 1.199 |
| | Coir | 106 | 24.4 | | |
| | Food Processing | 111 | 25.5 | | |
| | Tourism | 89 | 20.5 | | |
| | Others | 20 | 4.6 | | |
| **Business Operation** | Below 2 years | 117 | 26.9 | 2.45 | 1.119 |
| | 2–5 Years | 107 | 24.6 | | |
| | 6–10 Years | 110 | 25.3 | | |
| | Above 10 years | 101 | 23.2 | | |
| **Income Range** | Low | 114 | 26.2 | 2.12 | 0.795 |
| | Medium | 154 | 35.4 | | |
| | High | 167 | 38.4 | | |
| **No. of Employees** | 1–5 | 122 | 28.0 | 2.16 | 0.915 |
| | 6–10 | 150 | 34.5 | | |
| | 11–20 | 133 | 30.6 | | |
| | Above 20 | 30 | 6.9 | | |
| **Membership in SHG** | Yes | 114 | 26.2 | 1.74 | 0.440 |
| | No | 321 | 73.8 | | |

The highest proportion (32.6%) of the respondents were in the age group of 45–55 years followed by those in the 35–44 years category (30.8%), and then those aged above 55 years (15.1%). Young entrepreneurs and even teenagers below 25 years comprised a very small proportion (11.5%) of the sample, suggesting women entrepreneurship is more pronounced during the mid-life stage. The Mean age was 2.85 with SD of 1.008 indicating moderate concentration of women entrepreneurs at the middle age and possibly at a stage where they have necessary exposure, experiences and responsibilities in life. The responses to question regarding education showed an interesting pattern.

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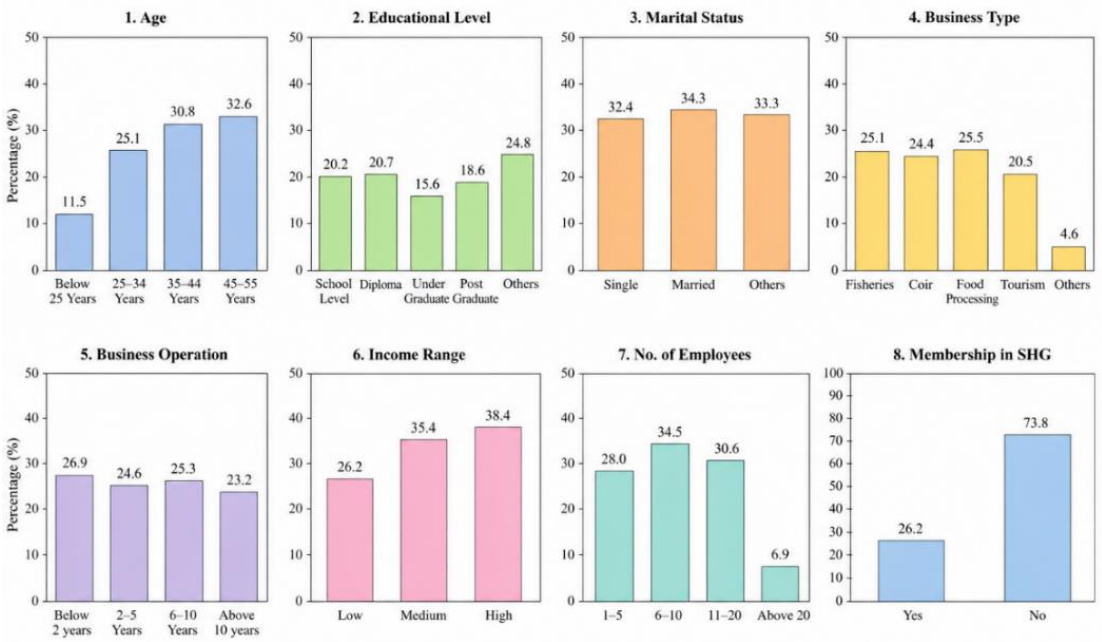


**Figure 2: Distribution of Socio-Demographic Characteristics (N=435)**

Though highest proportion of women entrepreneurs (20.2%) had finished school, followed by those with diploma or certificate courses (20.7%), the proportions with higher education including undergraduate (15.6%) and postgraduate degrees (18.6%) were equally significant. A considerable proportion of 24.8% responded as 'others' that might include various kinds of vocational courses or any other informal education programmes. The mean score for education was 3.07 with SD of 1.482 indicating mixed distribution.Although married women (34.3%) were almost equally distributed followed by singles (32.4%) and others (33.3%), there was hardly any variation in SD value of 0.812, indicating very little skewness in distribution. Hence, while examining issues of women-led enterprises it is useful to have an almost balanced distribution of marital statuses. Responses regarding type of enterprises indicated majority (63%) were into food processing, fisheries and coir enterprises with similar proportion (25.5%, 25.1% and 24.4%), possibly due to natural resource based enterprises having maximum potential for climate variability. Tourism (20.5%) was another category with significant proportion of respondents, and 'others' comprised a very small proportion of 4.6%. The mean score was 2.55 with SD of 1.199, thus moderately distributed. Distribution of years since enterprise was initiated indicated that while 26.9% had initiated less than 2 years ago, 25.3% were in the range of 6–10 years. The next two categories (2–5 years and above 10 years) also had very close proportions of 24.6% and 23.2% respectively. The mean was 2.45 with SD of 1.119. Thus, there are both new as well as established enterprises and therefore useful for exploring on climate adaptive measures. The economic status also indicated that there were majority in high income (38.4%) followed by medium (35.4%) and low (26.2%) income, indicating that positive trends in terms of income are prevailing among these women entrepreneurs. Hence, this challenges conventional understanding of micro-enterprises owned by women as purely low-income earning activities. Similarly, number of employees indicated that they were mostly micro enterprises with 6–10 employees (34.5%) and 11–20 employees (30.6%) followed by 1–5 employees (28%) and only 6.9% with more than 20 employees. The mean for number of employees was 2.16 with SD of 0.915 thus confirming that these were micro to small enterprises. Participation in self-help groups (SHGs) was observed to be low (26.2%) while 73.8% of respondents did not belong to any SHGs. The mean score of 1.74 with SD of 0.440 also indicates low participation from women

entrepreneurs. Given the context of Kerala, this is surprising, particularly in community-based initiatives where SHGs are seen as a platform to empower women through economic activities. Possibly there is a paradigm shift with increasing numbers of women being independent entrepreneurs and not requiring support systems like SHGs for running their microenterprises. Or else it may have to do with SHGs not reaching out effectively to these women.

**Table 2: Exploratory Factor Analysis and Confirmatory Factor Analysis**

| Rotated Component Matrixa | | | | | | | | Regression Weights | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Component | | | | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | Measured Variables | | Latent Variables | Estimate | P |
| CRP1 | .947 | | | | | | | CRP1 | < | CRP | .930 | *** |
| CRP2 | .938 | | | | | | | CRP2 | < | CRP | .922 | *** |
| CRP3 | .942 | | | | | | | CRP3 | < | CRP | .928 | *** |
| CRP4 | .943 | | | | | | | CRP4 | < | CRP | .927 | *** |
| RA1 | | .933 | | | | | | RA1 | < | RA | .905 | *** |
| RA2 | | .950 | | | | | | RA2 | < | RA | .938 | *** |
| RA3 | | .939 | | | | | | RA3 | < | RA | .920 | *** |
| RA4 | | .944 | | | | | | RA4 | < | RA | .928 | *** |
| IS1 | | | .947 | | | | | BP1 | < | BP | .902 | *** |
| IS2 | | | .935 | | | | | BP2 | < | BP | .920 | *** |
| IS3 | | | .943 | | | | | BP3 | < | BP | .914 | *** |
| IS4 | | | .937 | | | | | BP4 | < | BP | .907 | *** |
| AC1 | | | | .938 | | | | IS1 | < | IS | .933 | *** |
| AC2 | | | | .941 | | | | IS2 | < | IS | .911 | *** |
| AC3 | | | | .939 | | | | IS3 | < | IS | .930 | *** |
| AC4 | | | | .940 | | | | IS4 | < | IS | .913 | *** |
| GI1 | | | | | | .928 | | AC1 | < | AC | .919 | *** |
| GI2 | | | | | | .936 | | AC2 | < | AC | .925 | *** |
| GI3 | | | | | | .939 | | AC3 | < | AC | .917 | *** |
| GI4 | | | | | | .942 | | AC4 | < | AC | .921 | *** |
| GER1 | | | | | .945 | | | GER1 | < | GER | .936 | *** |
| GER2 | | | | | .941 | | | GER2 | < | GER | .921 | *** |
| GER3 | | | | | .918 | | | GER3 | < | GER | .880 | *** |
| GER4 | | | | | .952 | | | GER4 | < | GER | .944 | *** |
| BP1 | | | | | | | .927 | GI1 | < | GI | .904 | *** |
| BP2 | | | | | | | .938 | GI2 | < | GI | .920 | *** |
| BP3 | | | | | | | .936 | GI3 | < | GI | .920 | *** |
| BP4 | | | | | | | .934 | GI4 | < | GI | .924 | *** |
| Eigen values | 4.17 | 4.08 | 3.66 | 3.52 | 3.27 | 3.19 | 2.95 | Kaiser-Meyer-Olkin Measure of Sampling Adequacy: 0.847, Sig.: 0.000 | | | | |
| CR | 0.96 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | 0.95 | Composite Reliability | | | | |
| AVE | 0.86 | 0.84 | 0.84 | 0.84 | 0.84 | 0.83 | 0.82 | Convergent Validity | | | | |
| √AVE | .926 | .918 | .907 | .917 | .916 | .914 | .909 | Discriminant Validity | | | | |

Exploratory factor analysis (Table 2) supported a seven factor solution (explaining 91.52% of the variance), with high factor loadings and no cross-loadings that were significant at $p < 0.05$. The Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy was 0.847 which indicates that the sample was meritorious for factor analysis. The Bartlett's Test of Sphericity was significant ($p = 0.000$), thus indicating that the correlation matrix was not an identity matrix and factor analysis was appropriate for the items. Factor loadings for all items exceeded 0.70, and were 0.918, 0.929, 0.948, 0.952, 0.935, 0.923 and 0.922 (Author, Year). All the Eigen values for the seven constructs were greater than 1, the minimum threshold value, and varied from 2.95 to 4.17, thus indicating that it was appropriate to retain all seven constructs. The results indicated items had high internal consistency with the seven factor solution explaining 91.52% of the variance. Further validation of the measurement model was assessed via a confirmatory factor analysis using a Structural Equation Model. For the regression weights (standardized factor loadings), all observed variables loaded significantly onto the latent constructs ($p < 0.001$). In terms of internal consistency of the constructs all the Composite Reliability (CR) values were greater than 0.70 and in fact were reported at 0.95 and above. All the Average Extracted Variance (AVE) values indicated strong convergent validity and were greater than 0.50, ranging from 0.82 to 0.86. The results for the measurement model suggested that it met the standards for reliability, convergent validity and Discriminant Validity.

**Table 3: Standardized Regression Weights**

| Measured Variable | | Latent Variable | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| Adaptive_Capability | <--- | Climate_Risk | .386 | .039 | 9.093 | *** |
| Adaptive_Capability | <--- | Resource_Availability | .260 | .044 | 6.124 | *** |
| Green_Innovation | <--- | Institutional_Support | .281 | .036 | 6.813 | *** |
| Green_Innovation | <--- | Resource_Availability | .242 | .045 | 5.665 | *** |
| Green_Innovation | <--- | Adaptive_Capability | .296 | .043 | 6.926 | *** |
| Green_Entrep_Resilience | <--- | Adaptive_Capability | .402 | .048 | 9.649 | *** |
| Green_Entrep_Resilience | <--- | Green_Innovation | .210 | .048 | 5.111 | *** |
| Green_Entrep_Resilience | <--- | Institutional_Support | .058 | .038 | 1.564 | .118 |
| Green_Entrep_Resilience | <--- | Climate_Risk | .086 | .041 | 2.222 | .026 |
| Green_Entrep_Resilience | <--- | Resource_Availability | .246 | .046 | 6.466 | *** |
| Business_Performance | <--- | Green_Entrep_Resilience | .686 | .033 | 19.632 | *** |

Results from table 3 show that climate risk has a significant positive effect on adaptive capability ($\beta = 0.386$, C.R. = 9.093**, $p < 0.001$). Furthermore, results also show that resource availability has positive and significant effect on adaptive capability ($\beta = 0.260$, C.R. = 6.124**, $p < 0.001$). Specifically, results for green innovation indicate that institutional support has significant positive effect ($\beta = 0.281$, C.R. = 6.813**, $p < 0.001$). In addition to institutional support, results also show that resource availability ($\beta = 0.242$, C.R. = 5.665**, $p < 0.001$) and adaptive capability ($\beta = 0.296$, C.R. = 6.926**, $p < 0.001$) have positive and significant effects on green innovation. Most importantly, results clearly show that adaptive capability has the strongest effect in influencing green innovation. This finding underscores the significance of internal capability for harnessing external supports for innovation.

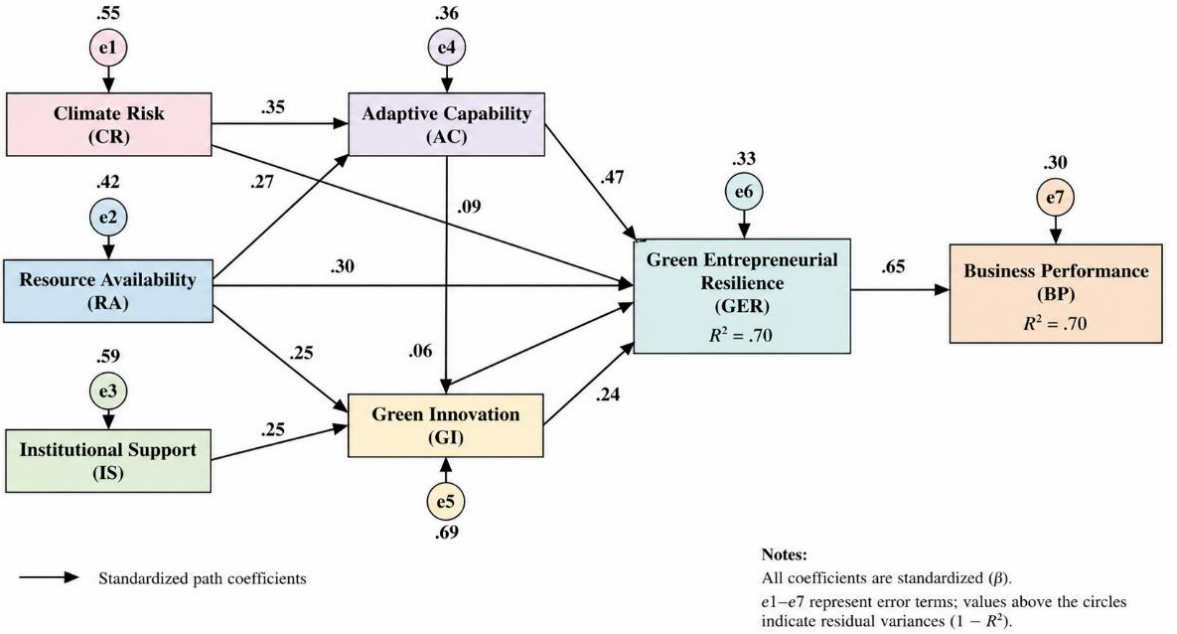


**Figure 3: Standardized Path Coefficients**

Regarding the determinants of green entrepreneurial resilience, the results (Figue 3) show that adaptive capability has the strongest effect (β = 0.402, C.R. = 9.649, p < 0.001), closely followed by resource availability (β = 0.246, C.R. = 6.466, p < 0.001) and green innovation (β = 0.210, C.R. = 5.111, p < 0.001). In this order, these three factors drive green entrepreneurial resilience mainly from a capability stance and with the support of available resources and necessary innovation. Climate risk has a very weak but significant direct effect on resilience (β = 0.086, C.R. = 2.222, p = 0.026), whereas, unlike the case for regular entrepreneurial resilience, institutional support does not have a significant direct impact on green entrepreneurial resilience (β = 0.058, C.R. = 1.564, p = 0.118). However, the effect may be indirect through an increase in capability and necessary innovation. Most importantly, green entrepreneurial resilience has the strongest effect on business performance (β = 0.686, C.R. = 19.632, p < 0.001).

**Table 4: Model Fit Indices**

| Fit Index | Obtained Value | Recommended Threshold | Interpretation |
|---|---|---|---|
| **CMIN/DF ($\chi^2$/df)** | 2.254 | < 3.00 | Good Fit |
| **p-value** | 0.013 | > 0.05 | Acceptable |
| **RMR** | 0.016 | < 0.08 | Excellent Fit |
| **GFI** | 0.986 | ≥ 0.90 | Excellent Fit |
| **AGFI** | 0.960 | ≥ 0.90 | Excellent Fit |
| **PGFI** | 0.352 | ≥ 0.50 | Marginal Fit |
| **NFI** | 0.972 | ≥ 0.90 | Excellent Fit |
| **RFI** | 0.940 | ≥ 0.90 | Good Fit |
| **IFI** | 0.984 | ≥ 0.90 | Excellent Fit |
| **TLI** | 0.966 | ≥ 0.90 | Excellent Fit |
| **CFI** | 0.984 | ≥ 0.90 | Excellent Fit |
| **RMSEA** | 0.054 | < 0.08 | Good Fit |
| **PCLOSE** | 0.375 | > 0.05 | Acceptable Fit |

The structural model presented here demonstrated overall good to excellent fit. First, the $\chi^2$/df value of 2.254 was well within range for acceptable fit, The Root Mean Square Residual (RMR) = .016, Goodness of Fit Index (GFI) = .986, and Adjusted Goodness of Fit Index (AGFI) = .960 all indicated excellent model fit. The incremental fit measures, NFI = .972, RFI = .940, IFI = .984, TLI = .966, and CFI = .984, also indicated that the model presented provided an excellent fit of the data. Finally, the RMSEA = .054 indicated a good approximation of the theoretical population model, and PCLOSE = .375 exceeded the critical .05 level. Thus, from a statistical standpoint, the proposed model was determined to be sound, fitting well and appropriate for use in hypothesis testing.

**Table 5: Structural Model Hypothesis Testing**

| Hypothesis | Path | Standardized β | Effect Type | Result |
|---|---|---|---|---|
| H1 | Climate Risk → Adaptive Capability | 0.386 | Direct | Supported |
| H2 | Resource Availability → Adaptive Capability | 0.260 | Direct | Supported |
| H3 | Climate Risk → Green Innovation | 0.000 | Indirect only | Not Supported (Direct) |
| H4 | Resource Availability → Green Innovation | 0.242 | Direct | Supported |
| H5 | Institutional Support → Green Innovation | 0.281 | Direct | Supported |
| H6 | Adaptive Capability → Green Innovation | 0.296 | Direct | Supported |
| H7 | Climate Risk → Green Entrepreneurial Resilience | 0.086 | Direct | Supported (Weak) |
| H8 | Resource Availability → Green Entrepreneurial Resilience | 0.246 | Direct | Supported |
| H9 | Institutional Support → Green Entrepreneurial Resilience | 0.058 | Direct | Supported (Weak) |
| H10 | Adaptive Capability → Green Entrepreneurial Resilience | 0.402 | Direct | Supported (Strong) |
| H11 | Green Innovation → Green Entrepreneurial Resilience | 0.210 | Direct | Supported |
| H12 | Green Entrepreneurial Resilience → Business Performance | 0.686 | Direct | Supported (Very Strong) |
| **Mediation Hypotheses (Indirect Effects)** | | | | |
| **Hypothesis** | **Path** | **Indirect Effect** | **Mediation Type** | **Result** |
| H13 | Climate Risk → Green Innovation (via AC) | 0.114 | Full Mediation | Supported |
| H14 | Resource Availability → Green Innovation (via AC) | 0.077 | Partial Mediation | Supported |
| H15 | Resource Availability → GER (via AC & GI) | 0.172 | Partial Mediation | Supported |
| H16 | Climate Risk → GER (via AC & GI) | 0.179 | Partial Mediation | Supported |

| | | | | |
|---|---|---|---|---|
| H17 | Institutional Support → GER (via GI) | 0.059 | Partial Mediation | Supported |
| H18 | All predictors → Business Performance (via GER) | 0.080–0.318 | Full Mediation | Supported |

Results from hypothesis testing (Table 5) support a coherent structural pattern for green entrepreneurial resilience. First, results for H1 and H2 suggest that climate risk (β = 0.386) and resource availability (β = 0.260) both have significant positive effects on adaptive capability. However, findings do not support the direct effect for H3 regarding whether climate risk has a significant positive effect on green innovation (β = 0.000). Yet findings do support H4, H5, and H6 in that resource availability, institutional support, and adaptive capability, respectively, all have significant positive effects on green innovation, with adaptive capability being the strongest predictor (β = 0.296). Moving to the effects on green entrepreneurial resilience, findings consistently support the effects proposed in H10 (adaptive capability, β = 0.402), H8 (resource availability, β = 0.246), and H11 (green innovation, β = 0.210), with adaptive capability having the strongest effect. Additionally, results indicate that climate risk (β = 0.086) and institutional support (β = 0.058) both have positive but weaker effects on green entrepreneurial resilience, supporting H7 and H9, respectively. For H12, findings indicate that green entrepreneurial resilience has a very strong positive effect on business performance (β = 0.686). Results from the mediation analysis offer further support to these findings. First, findings support H13 in that adaptive capability fully mediates the effect of climate risk on green innovation (β = 0.114). Second, results indicate that resource availability partially mediates the effect of climate risk on green innovation through adaptive capability (β = 0.077), supporting H14. Third, results demonstrate that resource availability (β = 0.172) and climate risk (β = 0.179) both affect green entrepreneurial resilience through sequential mediation by adaptive capability and green innovation, supporting H15 and H16, respectively. Results also support H17 in that institutional support affects green entrepreneurial resilience only through green innovation (β = 0.059). Finally, findings consistently indicate that all antecedent variables affect business performance fully through green entrepreneurial resilience, thereby supporting H18 (β = 0.080–0.318) (Figure 4).

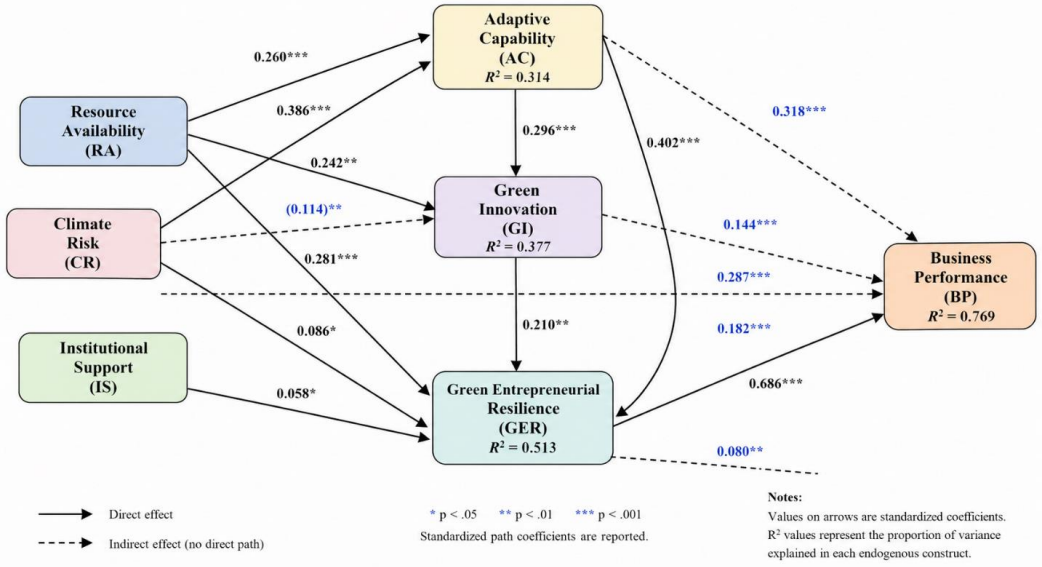


**Figure 4: Standardized Path Coefficients Direct and Indirect Effects**

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**Discussion**

Empirical evidence is growing that climate change has multifaceted effects on the functioning of enterprises across the globe, with small and medium-sized enterprises bearing greater risk than large enterprises due to limited resources, lack of innovative capacity, and the fragility of micro-enterprises in the face of extreme weather. In the wake of climate change, the resilience of 'green' entrepreneurial activities assumes great significance, which is particularly pronounced in the context of climate-vulnerable micro-enterprises seeking to sustain and improve their business performance. The results support a capability-driven and innovation-mediated approach by establishing the pivotal role of adaptive capability. Women entrepreneurs with greater adaptive capability translate external pressures into resilience-based outcomes. Importantly, climate risk, and resource availability are found to have a positive and significant impact on adaptive capability. Furthermore, in examining the antecedents of green innovation, the results indicate that adaptive capability acts as a crucial enabling factor. In contrast to common perceptions, climate risk does not directly affect green innovation. The findings therefore negate the notion of a straightforward link between climate risk and innovation, highlighting the need to move beyond linear conceptualizations of the climate adaptation process. Rather than treating women entrepreneurs as passive recipients of environmental shocks, this study presents them as active agents of climate adaptation, reinforcing their role as critical drivers of sustainable entrepreneurship in the face of climate change. The findings underscore the importance of developing adaptive capability to address climate risks through innovative practices, and suggest that women entrepreneurs with higher levels of adaptive capability are able to introduce more impactful green innovations, such as the use of environmentally friendly production techniques, diversification of income streams, and adoption of cost-effective technologies. In the context of coastal Kerala, where floods, salinity intrusion, and erosion are recurrent natural disasters, adaptive capacity for sustaining and enhancing the performance of micro-enterprises in traditionally vulnerable sectors, such as fisheries, coir, and food processing, is critical. The institutional support has a positive effect on green innovation, its effect on resilience is weak and non-significant. This finding can be read as a critique of the existing support systems and their relevance for actual needs of micro-enterprises. More targeted and contextual support may help to increase the resilience of micro-enterprises and improve their competitiveness.

The study also suggest that resource availability has both direct and indirect impacts on entrepreneurial resilience. Availability of financial capital, technology and information are found to positively enhance entrepreneurial adaptive capability and innovation, which in turn positively enhances resilience. Moreover, there is a significant positive effect of greening on resilience, and interestingly, entrepreneurial resilience is found to be the best predictor of business performance. This finding counters the conventional wisdom that environmental adaptation requires sacrifices for business performance and rather suggest that sustainability-oriented adaptation can lead to superior business performance. Women entrepreneurs who embed adaptive and innovative approaches into their entrepreneurial models are better placed to manage towards stability, clutch opportunities and achieve growth over time. Further, the results from the mediation analysis reveal that adaptive capability and green innovation operate as sequential mediators. Climate risk, resources and institutional support enhance resilience through these adaptive mechanisms which in turn enhance business performance. The results thus highlight the process-oriented nature of resilience. In particular, resilience is found to fully mediate the relationship between antecedents and business performance outcomes. The findings have important implications in rethinking the capacities and agency of women entrepreneurs in climate sensitive regions. Far from being victimized by a host of external factors, women entrepreneurs in coastal Kerala have developed innovative models of resilience that can transform vulnerability into

opportunity and signal the potential of women entrepreneurs as agents of inclusive growth and sustainability.

## Conclusion

This study contributes to the knowledge by formulating the concept of green entrepreneurial resilience and explaining how entrepreneurial activity could enhance climate change adaptation and sustainability. Dynamic capability theory provides the theoretical backbone for investigating the sustainable innovative performance of women-led micro-enterprises under environmental uncertainty. Exploring the crucial capabilities and processes linked to resilience, results reveal that incorporating adaptive capability and green innovation as mediators reveals how external pressures may get translated into sustainable performance. Significantly, the indirect effect through adaptive capability supports the proposition that while entrepreneurial activity is important for resilience building, it is not sufficient unless enhanced by capacity building. Moreover, risk perception does not automatically translate to innovation in the absence of entrepreneurial capability. While resources matter, evidence illustrates that for resilience building, capability is more important than resources; thus, a shift from a resource-based to a capability-based approach is essential. Policymakers, entrepreneurs, and supporters of entrepreneurship and women's empowerment can benefit from targeted programs that support skill development, climate risk management, and green technology led innovation. Empirical evidence from coastal Kerala, India suggests that institutional support barely has a direct impact on entrepreneurial resilience. The study's framework is explanatory and has high potential to explain entrepreneurial resilience. Analyzing additional factors, such as digital technology adoption, social capital, and market linking can enhance the insight and aid in creating more effective framework for entrepreneurship and resilience. Thus, this study presents evidence that women entrepreneurs are not passive victims of vulnerability due to climate change; they are proactive actors building resilience and sustainability within their businesses and communities. Specifically, adaptive capability and green innovation can translate climate risks into opportunities and assist in sustainable enterprise growth. Further, investing in women's capacities as entrepreneurs could be an effective mechanism towards climate resilience and sustainable development.

**Conflict of Interest Statement:** The authors declare that there is no conflict of interest related to this study.

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