

Determinant Indicators for Assessing the Adaptive Capacity of Agricultural Producers to Climate Change

María de Lourdes Maldonado-Méndez, José Luis Romo-Lozano and Alejandro Ismael Monterroso-Rivas

Table S1. Agricultural producers types identified by the authors.

TYPE	NOMENCLATURE
T1	Family subsistence producer with very high sensitivity and medium level of exposure to climate change
T2	Family subsistence producer with very high sensitivity and low level of exposure to climate change
T3	Family subsistence producer with very high sensitivity and very low level of exposure to climate change
T4	Family subsistence producer with high sensitivity and low-to-medium level of exposure to climate change
T5	Family subsistence producer with minimal conditions for diversification, high sensitivity, and very low–medium level of exposure to climate change
T6	Family subsistence producer with minimal conditions for diversification, medium–high sensitivity, and very low–low level of exposure to climate change
T7	Family producer with agricultural income, medium–high sensitivity, and very low–medium level of exposure to climate change
T8	Family producer with agricultural income, medium sensitivity, and very low–medium level of exposure to climate change
T9	Family producer with agricultural income, low–medium sensitivity, and very low–medium level of exposure to climate change
T10	Producer in transition with medium–high sensitivity, and low–medium level of exposure to climate change
T11	Producer in transition with low–medium sensitivity, and low–medium level of exposure to climate change
T12	Entrepreneurial producer with low profitability, low–medium sensitivity and low–medium level of exposure to climate change
T13	Entrepreneurial producer with low–medium sensitivity and low–medium level of exposure to climate change
T14	Entrepreneurial producer with low sensitivity and very low–medium level of exposure to climate change
T15	Entrepreneurial producer with very low–low sensitivity and very low–medium level of exposure to climate change
T16	Entrepreneurial producer with minimal-low sensitivity and very low–low level of exposure to climate change
T17	Entrepreneurial producer with very low sensitivity and low level of exposure to climate change
T18	Entrepreneurial producer with minimal sensitivity and very low–low level of exposure to climate change
T19	Entrepreneurial producer with minimal sensitivity and low–medium level of exposure to climate change

Source: Prepared by the authors

Table S2. Synthesis of the studies selected and analyzed for assessing the capacity to adapt to climate change.

Author	Method	Level/Sector	Dimensions	Indicators	Synthesis
Juhola, S. and Kruse S., 2013	An aggregate index was designed from a set of variables and a weighted average was calculated at the dimension level. The Delphi method is used, and it is qualified using government data and statistics.	Pan-European assessment of adaptive capacity and an assessment of the adaptive capacity of the tourism sector in the European Alps	Knowledge and awareness Technology Infrastructure Institutions Economics resources	CC1. Educational commitment CC2. Computer skills CC3. Attitudes towards climate change T1. Resources for technology T2. Capacity to undertake research T3. Patents I1. Transport I2. Water infrastructure I3. Health In 1. Government effectiveness In 2. National adaptation strategies In 3. Democracy RE. Income per capita RE. Age dependence RE. Unemployment	5 dimensions 15 indicators Source: Prepared by the authors based on Greiving et al., 2011
				HR1. Farming experience HR2. Educational attainment of household head HR3. Percentage of adults with primary education HR4. Percentage of adults in the household PhR1. Farm size PhR2. Irrigation PhR3. Ownership of farm implements/machines PhR4. Farm tenure RFi1. Remittances from family members RFi2. Value of animal units RFi3. Receives financial assistance/subsidy from the government RFi4. Has access to credit I1. Type of trainings on farming I2. Receives technical assistance I3. Participates in farm organization I4. Sources of climate information Ld1. Number of livelihoods/sources of income Ld2. Percentage of land not in crops Ld3. Number of crops planted	
Defiesta and Rapera, 2014	Through a process of analytical hierarchy and expert judgment, the indicators were weighted.	Agricultural sector	Human Resources Physical resources Financial resources Information Livelihood diversity		5 dimensions 19 indicators Source: Prepared by the authors

Author	Method	Level/Sector	Dimensions	Indicators	Synthesis
Lam et al., 2014	A vulnerability index was designed by combining the different variables representing the three dimensions using an arbitrary weighting scheme. To validate the derived vulnerability index, a regression analysis was performed between the actual damage data (dependent variable) and the predictor variables representing the three dimensions of vulnerability. The weights were revised according to the resultant regression coefficients, and the vulnerability index was recalculated and compared.	Coastal hazards in the Caribbean Region	Socioeconomics Technology Infrastructure	S1. Human Development Index S2. Property incidence S3. Income inequality T1. Electricity coverage I1. Road density I2. Communication	3 dimensions 6 indicators Source: Prepared by the authors based on Yusuf y Francisco, 2009; Brito y Arenas, 2009

Chen 2014	Descriptive data analysis was performed for all indicators. Correlation analysis and cluster analysis were used to determine the relationships between the different components of the AC index.	China's adaptive capacity to climatic variability and climate-related disasters, both at a national level and in a regionally	Natural capital engineering capital financial capital human capital social capital	CN1. Per capita freshwater resources availability	5 dimensions 46 indicators Source: Prepared by the authors based on Graedel et al. (2012)
				CN2. Percentage of natural wetland coverage	
				CN3. Percentage of forest land	
				CN4. Percentage of green space in urban area	
				CN5. Percentage of nature reserves	
				CN6. Per capita arable land area	
				CI1. Coverage of water supply in urban areas	
				CI2. Percentage of population with improved sources of drinking water in rural areas	
				CI3. Wastewater treatment rate in urban areas	
				CI4. Percentage of population with improved sanitation in rural areas	
				IC5. Percentage of areas with drainage capacity in rural areas	
				CI6. Ratio of reservoir capacity to renewable surface water resources	
				CI7. Percentage of population with flood protection in rural areas	
				IC8. Percent flood protection against a 50-year flood	
				CI9. Percentage of heating coverage	
				IC10. Percentage of population having access to gas	
				IC11. Road network density	
				IC12. Per capita public transport capacity	
				IC13. Transportation facility indicator	
				IC14. Number of agricultural machinery per arable land area	
				IC15. Irrigation capacity per arable land area	
				CF1. Per capita gross domestic production (GDP)	
				CF2. GDP growth rate	
				CF3. Per capita public revenue	
				CF4. Per capita public expenditure	
				CH1. Life expectancy at birth	
				CH2. Social dependency ratio	
				CH3. Natural population growth rate	
				CH4. Literacy rate	
				CH5. Average years of education	
				CH6. Percentage of population with higher education	
				CH7. Annual number of patents per 1,000 persons	

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Ruiz Meza L. E., 2015	Participatory methodology: interviews and participatory research workshops were used.	Adaptive capacity of small-scale coffee farmers to climate change impacts (Chiapas, Mexico)	Access to resources Flexibility Stability	CH8. Percentage of public expenditure on research and development (R&D) in GDP	3 dimensions 18 indicators Source: Prepared by the authors based on Wehbe et al., 2005
				CH9. Climate Observation capacity index	
				CS1. Percentage of population in poverty	
				CS2. Unemployment rate	
				CS3. Inflation rate	
				CS4. Number of doctors per 1,000 persons	
				CS5. Number of hospital beds per 1,000 persons	
				CS6. Per capita medical aid expenditure	
				CS7. Number of refrigerators per household	
				CS8. Number of air conditioners per household	
				CS9. Number of televisions per household	
				CS10. Number of telephones per household	
				CS11. Coverage of basic health insurance in urban areas	
				CS12. Coverage of basic health insurance in rural areas	
				A1. Natural resources (water and soil)	
				A2. Physical resources (infrastructure)	
				A3. Financial resources,	
				A4. Human Resources	
				A5. Social resources	
				A6. Political resources	
				A7. Public subsidies	
				A8. Social assistance in emergencies	
				A9. Technology options for adaptation	
				A10. Families with technology transfer and technical assistance	
				F1. Diversity of coffee varieties used	
				F2. Number of crops grown	
				F3. Production for subsistence and commercialization	
				F4. Diversity of income sources: agriculture, trade, non-agricultural salaries, remittance, income according to activity and family member.	
				E1. Variability of product prices	
				E2. Agricultural impacts and losses	
				E3. Erosion, landslides, and flooding	
				E4. Migration	

Author	Method	Level/Sector	Dimensions	Indicators	Synthesis
Lockwood 2015	They developed psychometric scales for these dimensions and tested their internal consistency (reliability) and validity (how well the measures define the construct) using factor analysis.	Agricultural landscape in Australia	Social capital	SC1. Local networks SC2. Trust SC3. Reciprocity	4 dimensions 14 indicators Source: Prepared by the authors
			Human, financial and physical capital	HFC1. Knowledge and information HFC2. Labor and time HFC3. Finance and infrastructure	
			Management approach	MA1. Innovation MA2. Adaptive management MA3. Risk behavior	
			Governance	G1. Legitimacy G2. Accountability G3. Inclusion and fairness G4. Leadership	
				G5. Coordination and collaboration	
Nhuan, 2016	They developed a survey based on the indicators approach to assess AC. Household survey data were processed using descriptive statistical methods, principal component analysis (PCA) and multiple linear regression analysis.	The adaptive capacity of urban households: The case of Da Nang city, Central Vietnam	Household economy	HE1. Wealth HE2. Housing conditions HE3. Durable assets	6 dimensions 17 indicators Source: Prepared by the authors
			Social relation	SR1. knowledge sharing SR2. Social Organizations SR3. Social support networks	
			Human capital	HC1. Education HC2. Knowledge HC3. Employment	
			Adaptation practices	AP1. Disaster Preparedness Measures AP2. Skills and experiences for disasters and CC	
			Municipal services and urban governance	AP3. Access to water sources during disasters	
Araya-Muñoz et al, 2016	They created a general framework of indicators, standardized and aggregated using fuzzy logic, and performed a sensitivity, uncertainty, and correlation analysis to assess robustness, using fuzzy overlay in ArcGIS 10.	Assessing urban adaptive capacity to climate change (Chile)	Livelihood protection	MSyG1. Health services MSyG2. Electricity supply MSyG3. Urban stability and security	6 dimensions 17 indicators Source: Prepared by the authors based on Acosta et al, 2013
			Knowledge and Equity	LP1. Livelihood diversity LP2. Insurance coverage	
			Technology, infrastructure and human health	KaE1. Female activity rate KaE2. income inequality KaE3. Alphabetization rate KaE4. Tertiary qualification	
			Economic resources, institutions and social capital	T1. Capacity to undertake research T2. Patents T3. Distance to hospital T4. Hospital beds T5. Physician T6. Transport	
				T7. Physical housing conditions T8. informal networks ERIS1. Income per capita ERIS2. Poverty ERIS3. Dependency ratio ERIS4. Municipal budget ERIS5. Master plan updates	

Author	Method	Level/Sector	Dimensions	Indicators	Synthesis
Abdul-Razak Majeed and Kruse Sylvia, 2017	Validation of determinants and indicators through interviews with experts.	Adaptive capacity to climate change of smallholder farmers (Northern Region of Ghana)	Economic resources Social capital Awareness and training Technology Infrastructure Institutions	ER1. Diversity of source of income ER2. Remittance ER3. Access to credit SC1. Access to family / household labour SC2. Participation in farmer-based organizations SC3. Participation in gender-based organizations SC4. Participation in religious-type organizations SC5. Participation in other organization	6 dimensions 22 indicators Source: Prepared by the authors based on 22 authors
	Ranking for each determinant and indicator was determined by the average of the ranking scores assigned to each one by all the experts.			AT1. Acceptance of climate change AT2. Level of literacy AT3. Access to climate information AT4. Farming experience AT5. Access to extension service T1. Knowledge of seed varieties T2. Knowledge of soil moisture retention techniques T3. Knowledge of soil fertility retention techniques I1. Landholding size I2. Irrigation infrastructure I3. Access to roads In 1. Land tenure arrangement In 2. Government subsidy In 3. Disaster Relief assistance	
Li Mengping et al., 2017	Pearson's correlation analysis to test the complementarity and substitution between indicators. Standardized regression coefficient and factor analysis to integrate complementary capital indicators, and a contribution rate of each factor was used to calculate the AC.	Adaptive capacity of apple farmers to drought events by impact of climate change (Loess Plateau, China).	Experience Infrastructure Material resources Technology Flexibility Economic resources	E1. Age E2. Farming years I1. Distance to agricultural fairs I2. Distance to markets RM1. Cultivated land area RM2. Housing type T1. Training T2. Village cadres F1. Household size F2. Non-agricultural income RE1. Number of relatives RE2. Agricultural income RE3. Current value of the house	6 dimensions 13 indicators Source: Prepared by the authors based on Bryan et al., 2015; Huai, 2016a; Sharp, 2003

Author	Method	Level/Sector	Dimensions	Indicators	Synthesis
Monterroso R. A. and Conde C., 2017	Standardization and normalization of the variables of each indicator. An AC index was estimated for each municipality and the final range of values was divided into five groups according to the geometric distribution of the frequencies of values.	Assesses the adaptive capacity of Mexican municipalities to address climate change	Human capital Social capital Financial capital Natural capital	HC1. Population aged 15 years and older who can read (%)	4 dimensions 19 indicators Source: Prepared by the authors
				HC2. School attendance by people from 6 to 24 years of age (%)	
				HC3. Literacy rate at municipality	
				HC4. Change in the municipality's population 2005–2030 (%)	
				SC1. Production units organized to access some support (%)	
				SC2. No litigation or disputes over land in Production units (%)	
				SC3. Production units with technical training (%)	
				SC4. Possession or land tenure (%)	
				SC5. Civil protection office (0=no, 1=yes)	
				SC6. Map of natural hazards (0=no, 1=yes)	
				FC1. Production units without difficulty accessing credit (%)	
				FC2. Production units that receive remittances from abroad (%)	
				FC3. Production units reporting some type of savings (%)	
				FC4. Production units with credit and insurance coverage (%)	
				FC5. Gross domestic product in 2000 (×1000 US\$)	
				FC6. Population with income greater than two times the minimum wage (%)	
				NC1. Surface with forests and/or rainforests (ha)	
				NC2. Reforested surface in the municipality (ha)	
				NC3. Rate of water extraction from aquifers	

Author	Method	Level/Sector	Dimensions	Indicators	Synthesis
Holland, 2017	An AC index was created, the variables were selected through interviews with 109 experts and 3 indicator validation workshops were held.	Mapping adaptive capacity and smallholder agriculture (Central America)	Financial assets Social assets Physical assets Human assets Natural assets	FA1. Investments to improve crop production: fertilizers, pesticides, soil preparation / tilling and Irrigation (high input) FA2. Access to credits FA3. Access to subsidies FA4. Diverse income sources FA5. Receive remittances AS1. Migration AS2. Receive assistance after extreme events	5 dimensions
				FiA1. Mitigation of crop damage: chemical control of pests and disease and/or integrated pest management (IPM) FiA2. Access to market or small grocery store for sale FiA3. Access to storage of crop product FiA4. Access to transportation to market FiA5. Access to agricultural machinery/equipment HA1. Access to human labor NA1. Implementats soil conservation practices.	14 indicators Source: Prepared by the authors
Hoan N., 2019	Qualitative methods: it was based on rating motivation and abilities (MOTA). An AC index was designed based on farmers' motivation and abilities and semi-structured interviews were conducted to assess the perception, motivation and capacity of farmers.	Assessing the adaptive capacity of farmers under the impact of saltwater intrusion by effect to climate change (Vietnamese Mekong Delta)	Financial ability Technical ability Institutional ability	HF1. Budgets: average monthly income and loan for production HF2. Production resources: water quantity and quality and amount of selective seeding HT1. Infrastructure and technique: possession of equipment and tools for production, machinery, roads, Irrigation HT2. Knowledge and skills: educational level, farming experience, rate of participation in trainings HI1. Social organization: rate of participation in agricultural and non-agricultural organization HI2. Market: Number of purchasing agents and Change in market prices	3 dimensions 6 indicators 14 sub indicators Source: Prepared by the authors based on Fogg, 2009

Author	Method	Level/Sector	Dimensions	Indicators	Synthesis
Zanmassou Y. et al., 2020	Five groups of indicators were created based on the five capitals, the data were normalized and two weighting schemes were used to combine the indicators in a composite index: equal weighting and expert judgment. In order to analyze the consistency of the uncertainty, a Monte Carlo simulation was performed.	Assessment of smallholder farmers' adaptive Capacity to climate change (Benin, Africa)	Social capital Human capital Physical capital Natural capitals Financial capital	SC1. Member of a farmer organization SC2. Number of relatives in the community SC3. Participation in community activities HC1. Year of schooling HC2. Experience in agriculture HC3. Number of crops grown HC4. Visits of extension services HC5. Received a training in agriculture	6 dimensions
				FC1. Total area cropped FC2. Distance house to farm FC3. Distance house to market FC4. Distance house to financial institution FC5. Distance house to extension services office NC1. Rainfall variability NC2. Soil fertility NC3. Land ownership NC4. Experienced with natural hazard events on the farm. FnC1. Off farm income FnC2. Value of livestock FnC3. Crop income FnC4. Value of agricultural equipment FnC5. Credit sources diversification	22 indicators Source: Prepared by the authors based on 11 authors
Matewos T., 2020	Mixed research: qualitative and quantitative data were collected. Cross-sectional household surveys, key informant interviews and focus group discussions were used to collect relevant data.	Local adaptive capacity to climate change in drought prone (districts of rural Sidama, Ethiopia)	Asset basis Institutions and rights Knowledge and information Innovation Flexible Forward-looking Decision Making (MFDM) and governance	AB1. Land holding size AB2. Land use right AB3. Livelihoods characteristics AB4. Participation in on-farm livelihood activities AB5. Participation off-farm livelihood activities I1. Availability of formal and informal institutions KI1. Literacy level KI2. Access to weather forecast KI3. Early warning KI4. Market and government support information In1. Agricultural inputs In 2. Agricultural extension services In 3. Small scale irrigation G1. Types and characteristics of adaptive decisions made by farmers	5 dimensions 14 indicators Source: Prepared by authors based on Ludi et al., 2011

Author	Method	Level/Sector	Dimensions	Indicators	Synthesis
W. Chepkoech, et al., 2020	They conducted an expert online rating survey (n = 35). The Kruskal-Wallis H test and a <i>t</i> -test were used to test the independence of AC scores and the access to existing resources.	Adaptive capacity of smallholder African indigenous vegetable farmers to climate change (Kenya)	Natural capitals Physical capital Financial capital Human capital Social capital	CN1. Type of land ownership	5 dimensions 20 indicators Source: Prepared by authors based on Abdul-Razak y Kruse (2017), Defiesta y Rapera (2014), Eakin y Bojorquez Tapia (2008).
				CN2. Size of land in acres	
				CN3. Source of water	
				CN4. Decision over land management	
				CF1. Type of irrigation	
				CF2. Total number of assets	
				CF3. Ownership of basic farm tools	
				CF4. Ownership of farm machinery	
				CFn1. Off-farm income	
				CFn2. Formal/informal credit	
				CFn3. Number of income sources	
				CFn4. Number of farm workers	
				CH1. Education level	
				CH2. Number of years in farming	
				CH3. Size of household	
				CH4. Number of adults	
				CS1. Frequency of extension	
				CS2. Weather forecast information	
CS3. Group membership					
CS4. Number of sources of weather information					
Abbas Khan N. et. al., 2020	Data were acquired through a farm-level survey, and the variables obtained were grouped into three clusters. Principal component analysis was applied as an exploratory analysis. The data were normalized and weights were assigned to each variable according to expert judgment and the AC Index was calculated.	Mapping rice farmers’ adaptive capacity of Agricultura (productors de arroz)	Socioeconom ic capacity Agricultural capacity Institutional capacity	CS1. Education: farmers' average years of schooling	3 dimensions 11 indicators Source: Prepared by the authors based on Sendhil R. et al., 2018
				CS2. Farm Income	
				CS3. Off-farm income sources	
				AC1. Landholding	
				CA2. Farming experience	
				CA3. Farm labor	
				AC4. Farmers who own livestock	
				CA5. Farmers who adopted climate adaptation strategies	
				CI1. Credit access	
				CI2. Advisory received	
				CI3. Farmers with access to climate information	

Author	Method	Level/Sector	Dimensions	Indicators	Synthesis
Choden, 2020	Households selected through simple random sampling were surveyed on perception of changes in climate and on available capital assets. A factor analysis was performed using Varimax with Kaiser normalization rotation and a Principal Component Analysis (PCA).	Assessment of adaptive capacity to climate change at household and village-levels. (Nikachu, Bután)	Human capital Natural Capital Capital (resources) Natural Capital (Access) Financial capital Physical capital Social capital	HC1. Educational level of the head of the household HC2. Walking time to the nearest Basic Health Unit HC3. Training on climate change adaptation NC1. Land holding per household NC2. Forest cover NC3. Meadows NC4. Shrubs NCA1. Protected area/village NCA2. Community forest/village FC1. Proportion of climate-sensitive resources income to total income FC2. Proportion of off-farm income to total income FC3. Total income FC4. Livelihood Diversity Index PhC1. House type Ph2. Walking time to the nearest market PhC3. Road type SC1. Membership in social organizations by household SC2. Gender SC3. Household number	6 dimensions 19 indicators Source: Prepared by the authors
Putri, 2020	Through interviews with key informants selected through purposive sampling and an AC index was created.	Community adaptive capacity (Semarang, Indonesia)	Economics Social Information and Technology Infrastructure Innovation	E1. Household Economics Condition E2. Asset ownership S1. Participation in Community S2. Access to aid IT1. Information about climate change I1. Access to infrastructure provided In1. Willingness to adapt	5 dimensions 7 indicators Source: Prepared by the authors

Author	Method	Level/Sector	Dimensions	Indicators	Synthesis
Parveen, 2022	A tree of decision criteria was built, the criteria were standardized on a 0-1 scale range and finally a climate change vulnerability assessment was conducted.	Climate change vulnerability assessment: a case study in the Indian	Basic facilities Economic aspect Social aspect	BF1. Accessibility to clean drinking water connection	3 dimensions 10 indicators Source: Prepared by authors based on 10 authors
				BF2. Accessibility to efficient cooking fuel	
				BF3. Accessibility to public transport	
				EA1. Percentage of households who own their homes	
				EA2. Percentage of households owning any kind of asset	
				EA3. Local government or communities-based organization	
				EA4. Awareness and knowledge of different policies and scheme run by local government	
				SA1. Percentage of people who are literate	
				SA2. Social welfare programmes	
				SA3. Accessibility of media	

Table S3. Definition of terms used in the article.

Dimension	refers to the group of aspects or components that represent a type of potentialities or similar resources, for example: economic, social, human, natural, etc. Some authors describe it as themes, pillars, or capitals
Specific dimension	refers to each aspect of the adaptive capacity that is considered relevant and that contributes to the measurement of each dimension, this can be estimated through one or more indicators, depending on its complexity
Indicator	refers to a function between one or more variables, which allows measuring a specific attribute or aspect of a system or situation
Composite indicator	combination of a set of indicators that allows a complex component or a multidimensional concept to be measured, summarizing it in a simple index (one-dimensional)
Adaptive capacity	The ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences (IPCC, 2022)
Adaptation	refers to the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities (IPCC, 2022)