**Title and Project Coordination:** The paradoxes of climate-smart coffee (PACSMAC) - Project Coordinator Dr. Kristjan Jespersen

**State of the Art and Rationale**

Global environmental change threatens smallholder livelihoods across the Global South. Coffee growers, whose crop is very sensitive to temperature and precipitation change, are especially at risk. Global warming may reduce yields, shrink optimal growing areas, and foment more frequent and widespread pest and disease outbreaks (Pham et al., 2019; Kweka & Ouma, 2019). Arabica cultivation is under particular pressure, with Robusta less threatened (Craparo et al., 2015; Bunn et al., 2019). Regardless of their cultivar, impoverished coffee growers have limited capacity to adapt to climate-related challenges (Quiroga et al., 2020), so these impacts likely would further entrench them in poverty cycles. Downstream, coffee buyers worry declining production volumes in highly-value Arabica cultivation areas threaten their present investments (Bunn et al. 2015).

Anticipating these risks, actors along the coffee value chain (VC), such as farmers, government agencies, coffee roasters and traders, and development-focused NGOs, are experimenting with adaptation and mitigation innovations. These include new cultivars, climate-smart farming techniques and new land-use strategies (Fischersworring et al., 2015, Todo & Takahashi, 2013). These experiments' success, side effects, and benefits, however, will depend on how the entire VC responds. Historically, coffee VCs have featured substantial power asymmetries, which facilitated extractivist business practices, with the lion's share of economic benefits accruing in the Global North (Grabs and Ponte, 2019; Mojo et al., 2017). These power asymmetries could cause climate adaptation and mitigation innovations to produce paradoxical results. On the one hand, climate-smart agriculture could facilitate upgrading - helping some coffee farmers differentiate themselves and more added value or better market access (Gereffi, 1999, 2014; Mojo et al., 2015). On the other, adaptation and mitigation programs could make smallholders even more dependent on lead firms for inputs, expertise and market connections. To date, little empirical work has been done that would help stakeholders anticipate and address such paradoxical outcomes.

To assess climate change's likely agro-ecological and livelihood impacts, PACSMAC will study transformations in agricultural practices, business strategies, and stakeholder relationships in Ethiopia and Tanzania's coffee VCs. With expertise in both country's coffee VCs, the PACSMAC team is well positioned to analyze sectoral changes and model possible future scenarios informed by archival, ethnographic, focus group, interview, survey, and geospatial data. The study makes both empirical and theoretical advances.

Empirically, while some recent studies address climate-smart coffee, most existing knowledge addresses only agronomic strategies to support production (Jaramillo et al. 2011, Läderach et al. 2017, Pham et al. 2019). Literature on sustainability governance and upgrading in coffee GVCs, in turn, only covers certification systems and relationship coffee business models (Bray & Nielson, 2017, Vicol et al. 2018), with little attention to how climate change, in addition to consumer preferences, (re)shapes the sector. Moving beyond this knowledge base, PACSMAC will analyze how climate change adaptation and mitigation innovations may (re)shape governance and upgrading along the *whole* coffee VC in order to understand how impacts on and strategies of coffee farmers and downstream firms interact.

In theoretical terms, PACSMAC takes on Neilson's (2019) recommendation that future work on Global Value Chains (GVCs) and Global Production Networks (GPNs) in agricultural

supply chains, such as smallholder coffee production in the Global South, should pay greater attention to developing and applying the concept of "livelihood upgrading". Existing VC research assesses how firms, farmers and workers add value to products from their primary sources to their end uses (Gereffi, 1994) and analyzes how corporations shape VC governance, upgrading opportunities and benefit distribution (Gereffi et al., 2005; Ponte and Sturgeon, 2014). Discussions in development research and policy, meanwhile, have helped develop the Sustainable Livelihoods Approach as a comprehensive framework to conceptualize and promote people-centered development (Scoones 2009). While numerous development interventions explicitly target value-chain upgrading to alleviate poverty (Mayer and Gereffi 2019), whether or not product, process, functional or inter-sectoral upgrading will improve smallholders' livelihoods in any given case remains an open question (Ponte and Ewert 2009; Neilson and Shonk 2014; Howland et al., 2020). While upgrading might support higher incomes, smallholders face a tradeoff between diversified livelihood portfolios and specialization in a marketable commodity (Le Polain de Waroux and Lambin, 2013). Facing close survival margins, impoverished rural households also are often risk intolerant, while upgrading and market production often lead to high risk exposure (Loc, Bush and Khiem 2010). There are clear connections between the two literatures. The level and types of risk upgrading presents will depend on broader VC structures, while firms' strategies downstream in the VC depend in part on how producers respond to these risks. Nonetheless, there has been no consistent theoretical integration between the GVC/GPN and the sustainable livelihoods literature when evaluating 'value chains for development' interventions (Neilson 2019). Our project fills this research gap by further developing the concept of 'livelihood upgrading' in the context of climate-change risks and evaluating how synergies and trade-offs may arise between VC upgrading and livelihood improvement.

Climate mitigation and adaptation are likely to offer two main challenges and two main opportunities for smallholder coffee growers:

- **Challenge 1**: Increasing temperatures and erratic rainfall, assuming no change to planted cultivars, may force Arabica producers to seek higher altitudes, potentially sparking land conflict, deforestation, and other socio-economic and socio-ecological pressures (Ovalle-Rivera et al., 2015; Todo et al., 2011).
- **Challenge 2**: Locally-adapted cultivars may be necessary for climate-smart coffee. Countries with sophisticated research infrastructure and suitable genebanks are in a better position to create such variants (van der Vossen et al., 2015) and therefore might enjoy a relative market advantage.
- **Opportunity 1**: Some farmers, by adopting shade-grown, no-deforestation, permaculture-integrated, and/or locally-adapted coffee, may receive a 'climate-friendly market premium' from certification, geographic indications of origin or carbon credits (Bunn et al., 2019).
- **Opportunity 2**: International coffee traders may decide to support local climate adaptation to secure coffee supplies, restructuring their VC position (Grabs and Carodenuto, under review).

In short, as shown in the simplified flowchart below, farmers and firms in the coffee VCs are likely to respond to climate change with strategies that will affect VC structures, livelihoods, land use, and land cover. Not only are different national contexts likely to affect both groups' strategies, but these strategies will certainly affect each other. All this means that

understanding how climate change and efforts to mitigate or adapt to it will affect environmental and livelihood outcomes requires a detailed contextual understanding of coffee production from cultivation to consumption.

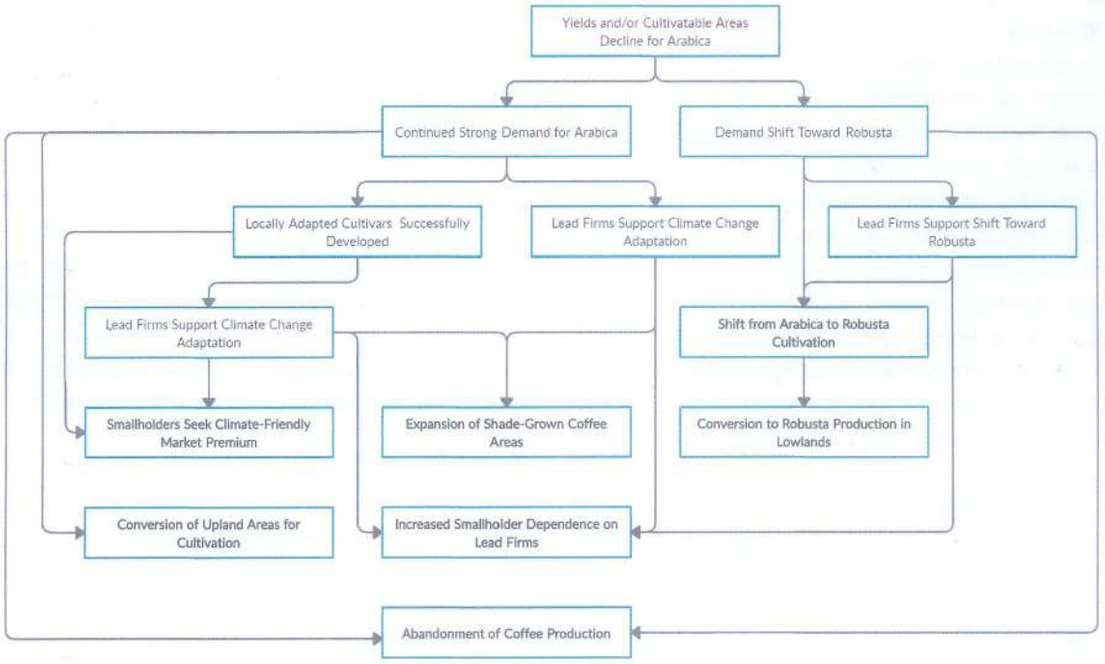


**Figure 1.** Schematic flowchart of the primary factors PACSMAC intends to investigate, with expected outcomes for smallholders highlighted in boldface.

**Relevance**

Ethiopia and Tanzania's coffee sectors exhibit empirically important contrasts. Ethiopian coffee commands high export market prices, Tanzanian less so (ICO, 2019). Ethiopia produces only Arabica, while Tanzania produces both Arabica and Robusta, positioning them differently in global VCs. Most global production is Arabica (USDA, 2019), which commands higher prices (ICO, 2019). Demand for Robusta, however, is growing more quickly (Kurose, 2019), and, as noted above, the cultivar is less susceptible to climate change (Craparo et al., 2015; Bunn et al., 2019). Improvements in management, upstream marketing and agricultural extension have boosted prices and productivity in Ethiopia (Minten et al., 2019), while Tanzanian farmers face low yields and an under-resourced extension system (Otieno et al., 2019). The Ethiopian Intellectual Property (IP) office has been promoting geographic indications of origin domestically and internationally, and has developed new proprietary genetic variations (Yadessa, 2014; Richerzhagen & Virchow, 2007). Tanzania has less sophisticated infrastructure and intellectual property management. Ethiopia has a larger proportion of shade-grown and permaculture-integrated coffee than Tanzania, positioning it better for climate-friendly premiums (Bunn, 2019). These differences likely will result in divergent adaptation trajectories (van Rikxoort et al., 2013, Hirons et al., 2019). For Ethiopian smallholders, climate-smart agriculture with climate-robust Arabica varietals could be an option, while land abandonment, crop switching, or a shift to Robusta

may be more likely in Tanzania, particularly if Robusta demand continues to grow in Asian markets.

The proposed research initiative is of strategic importance for Danish development cooperation. Under its strategic objective of *Inclusive, Sustainable Growth and Development,* Denmark is committed to supporting smart, sustainable, and equitable agricultural development, which requires supportive VC structures. In addition, the P4G network and the Danish government's investment in the Sustainable Trade Initiative (IDH) demonstrate the government's recognition that sustainable and equitable global VCs are essential to the country's sustainability ambitions. IDH has ongoing sustainable coffee projects in both PACSMAC partner countries. At the embassy level, Denmark supports the Ethiopian government's green economy and carbon-neutral growth, hoping to see Ethiopia achieve middle-income status by 2025. Denmark's embassy directly supports Ethiopia's Growth and Transformation Plan II (GTPII). In Tanzania, Denmark has supported initiatives focused on climate resilient livelihoods, green rice, and forest conservation. While the innovations we study are intended to address SDG 13 (Climate Action), their application in a GVC also may involve trade-offs for SDGs 8 (Decent Work), 12 (Sustainable Production and Consumption), and 14 (Life on Land).

**Objectives**

PACSMAC convenes researchers from CBS, the University of Jimma and the University of Dar es Salaam, to study how climate change and climate-change adaptation and mitigation strategies currently affect Ethiopia and Tanzania's coffee VCs and might further (re)shape them in the medium and long term. Further, the project will examine how these transformations redistribute value-adding activities, economic benefits and environmental impacts spatially and across VCs. Three main questions guide the research:

1. *How might climate change itself, alongside the mitigation and adaptation efforts intended to address it, affect the governance of coffee VCs originating in Ethiopia and Tanzania?*
2. *How do these changes affect the distribution of value along the chain, upgrading opportunities and farmer livelihoods?*
3. *How might these changes reshape the geography of coffee production and forest cover?*

PACSMAC will contribute to scientific knowledge in several ways. First, it investigates the interaction between climate change, VCs, and farmer livelihoods, a critical but poorly understood sustainability nexus (Challies, et al., 2019; Neilson, 2019). Second, studying coffee VCs can identify risks that may emerge in other agricultural sectors. Because coffee is a particularly climate-sensitive crop, experience with it can inform scenarios for other sectoral futures. Finally, PACSMAC will develop policy recommendations (on land use, adaptive cultivars, intellectual property management and governmental policy) informed by an improved understanding of producer livelihoods and interactions with broader VC processes. PACSMAC researchers will work in one of two work packages (WP):

**WP1: Tracing changes in governance and upgrading along the coffee value chain**

WP1 will study the connections between climate change mitigation and adaptation, firm strategies and governance downstream of producers in the Ethiopian and Tanzanian coffee VCs. First, WP members will collect secondary data focusing on coffee producers, industry

actors, NGOs and government agencies central to coffee VC governance in Tanzania and Ethiopia and catalogue these groups' activities related to climate-change adaptation and mitigation. During this phase, they will collect time-series data on farm-gate and free on board (i.e. ready to export) prices from official sources, such as the Ethiopian Commodity Exchange and the Tanzania Coffee Board. They will use this preliminary research to identify key informants to interview in the downstream VC sectors. These will include representatives of coffee VC actor groups, such as managers of cooperative unions; large-scale estates; central pulping stations, local traders; exporters; input and broader service providers; certifiers of sustainability standards, consultants and auditing firms; agricultural development project managers; regulators; and research institutions. They will further engage in participant observation at industry meetings, conferences, and export auctions in origin countries.

WP members also will interview actors involved in Ethiopian and Tanzanian coffee VCs operating outside these two countries. These actors include international traders; mainstream coffee roasters; supermarket chains; specialty coffee roasters, niche and large chain coffee shops and cafés in selected end-markets (Denmark, Italy, Germany, Switzerland, and the United States). Interviews will also cover Northern-based NGOs and major donor agencies active in climate change adaptation projects in the coffee sector; the International Coffee Organization; the World Intellectual Property Organization; the Specialty Coffee Association (European & US chapter) and other relevant industry associations and organizations. WP members will also conduct participant observation at relevant industry forums (e.g. Global Coffee Platform, World of Coffee Expo).

WP members will combine quantitative and qualitative evidence from these data sources, using process-tracing methods to identify causal mechanisms leading from climate change risks and adaptation and mitigation measures to changes in coffee VC governance, upgrading opportunities, value (re)distribution and new power relations. They will work closely with WP2 members to incorporate their early findings into fieldwork site selection and the design and analysis of focus-group interviews and livelihood surveys.

**WP2: Tracing responses to climate change at the local scale**

Like WP1, WP2 members will begin with a desk-based study, in this case focusing on existing interventions, policies, and property-rights regimes relevant to coffee cultivation and production in Ethiopia and Tanzania, with particular emphasis on implications for crop-shifting and opportunities to secure climate-friendly premiums. They will also assess the state-of-the-art in climate-tolerant cultivar development and knowledge on climate change's impacts on Arabica and Robusta cultivation. During this phase, the team will work with WP1 members to identify specific sites for fieldwork in the main producing areas in the two countries (Kagera, Mbeya/Mbinga and Kilimanjaro/Arusha in Tanzania; Tepi/Bebeka, Metu/Jimma and Gera in Ethiopia).

The WP2 team will start fieldwork in selected villages by facilitating gender-and-age-segregated focus groups. They will use these sources of information to inventory relevant local conditions These include existing and past interventions, projects, policies, and forms of support for climate adaptation; climate-change impacts, particularly in relation to agriculture; property regimes; and land-use histories. During this phase, team members will also conduct key informant interviews with village government officials, village natural resource committee members, elders, large-scale estate managers, input suppliers, local NGOs, and extension

agents. Team members will integrate information from the focus groups and interviews, with input from WP1 members, to design a sustainable livelihoods survey. WP2 members will conduct this survey with random samples of households in each study village to measure changes over the past decade in socio-economic status, agro-ecological practices, buyers' expectations, coffee prices and cultivars, climate change perceptions, strategies for managing climate risks, non-climate-related factors affecting coffee cultivation and marketing, and desirability of cultivating Arabica versus Robusta.

During the focus-group phase, WP2 team members will also collect ground-truthing points around the study villages, identifying the locations of shade- and non-shade-grown coffee, different coffee cultivars and other land uses. During the survey phase, team members with remote sensing expertise will use machine learning classification tools implemented in Google Earth Engine and these ground-truthing points to identify the locations of different production systems and other forms of land cover around the study villages over time. Using local climatological predictions and results from econometric modelling of local land-cover change, the GIS team will construct model-based scenarios of future local coffee production geographies and greenhouse gas emissions and carbon stocks from attendant land-use change. They will pay attention, in particular, to the potential effects of switching from Arabica to Robusta and climate-smart coffee cultivation on local agricultural geographies, using data from the surveys to assess these shifts' potential livelihoods implications.

**Collaboration across WPs.** To facilitate consistency and collaboration across work packages, PACSMAC administrators will convene regular virtual WP and whole-project meetings. This will allow team members to share experiences and preliminary findings as their fieldwork progresses, allowing both teams to take advantage of emerging findings as the research continues. This will also give the team members opportunities to construct theoretical models of the connections between upstream and downstream dynamics in coffee VCs.

**Project governance, management and coordination.** CBS will be responsible for overall administrative processes in collaboration with a senior faculty representative from both University of Dar es Salaam and Jimma University. These project administrators will be in charge of convening collaboration meetings, ensuring compliance with all regulations, and liaising with WP leaders and COVID-19 officers.

**Expected outcomes and outputs**

To maximize the benefits from the project, the project partners will undertake:

- **Capacity Building**
  - 4 PhD theses;
  - All senior faculty publishing at least one article in peer reviewed journals
  - All members will upgrade their methodological and communication portfolio (e.g. in the use of NVivo, R, ArcGIS Pro, QGIS, Google Earth Engine, media dissemination, social media management)
- **Research**
  - 5-8 journal articles in international peer- reviewed journals;
  - 8 presentations at international conferences;
  - 2 hosted workshops and a final conference

**- Policy, societal and community engagement**

- 3-4 policy briefs provided open-access in multiple languages;
- 8 articles or opinion pieces in local languages in Tanzanian and Ethiopian newsmedia
- 1 Facebook page, 1 twitter account, 1 interactive webpage
- Local-level dissemination efforts (posters, videos, multimedia events)
- Stakeholder engagement through ongoing meetings with an advisory board and an engagement session in the final conference
- Teaching cases in relevant languages, suitable for a higher-education classroom setting, freely available online

**Methodology**

PACSMAC will use mixed methods, combining qualitative data from focus groups, interviews and ethnography with quantitative survey and geospatial data:

- Secondary data collection, focus groups, and key informant interviews to identify existing initiatives, legislation and policies affecting coffee VCs in Ethiopia and Tanzania (WP1).
- Semi-structured interviews with VC actors inside the target countries as well as along the VC reaching European and US markets (WP1).
- Participant observation of important industry events (meetings, conferences, round tables) (WP1).
- Livelihoods survey, focus groups and key informant interviews to identify changes in coffee livelihoods in selected villages (WP1/2)
- Remote sensing data, processed into land-cover classes using machine learning algorithms available through Google Earth Engine, and geographic information systems (GIS) to model present and future cultivation areas (WP2)

To answer RQ1 (*How might climate change itself, alongside the mitigation and adaptation efforts intended to address it, affect the governance of coffee VCs originating in Ethiopia and Tanzania?),* WP1 members will analyze secondary data, semi-structured interviews and participant observation using cross-case, comparative pattern searching (Eisenhardt 1989, 1991) and process tracing (Bennett and Checkel 2004, George and Bennett 2005). The team will extract additional information from the pattern-searching analysis by iteratively contrasting cases with each other, tracing causal mechanisms across scales, and tracing processes across time (Bartlett and Vavrus 2016).

To answer RQ2 (*How do these changes affect the distribution of value along the chain, upgrading opportunities and farmer livelihoods?),* members of both WPs will use qualitative evidence from focus groups and semi-structured interviews to identify plausible causal mechanisms affecting coffee farmers' livelihoods strategies, which WP2 members will test using data from the livelihood survey. Using propensity score matching estimated via generalized boosted models (Griffin, et al., 2014), these researchers will identify the differential impacts, if any, of climate change adaptation on producers along gradients of age, gender, socio-economic status, and production geography.

Finally, to answer RQ3 (*How might these changes reshape the geography of coffee production and forest cover?),* we will use time-series multistate models (Beyersmann, et al., 2012) to estimate and simulate drivers of change in local coffee cultivation geographies. Combining these models with results from the livelihoods survey, WP2 team members will

conduct simulations from which to construct scenarios, informed by both WPs qualitative findings, of future local coffee production geographies and estimate greenhouse gas emissions and carbon stocks from attendant land-use change.

**Overview of the Research Plan**

Table 1 presents the project timeline, highlighting key milestones. In preparation for these activities, PhD candidate selection, work package preparation and convening workshop planning will begin upon the proposal's acceptance. The project administrators and work package team leaders will interview and select PhD candidates by consensus.

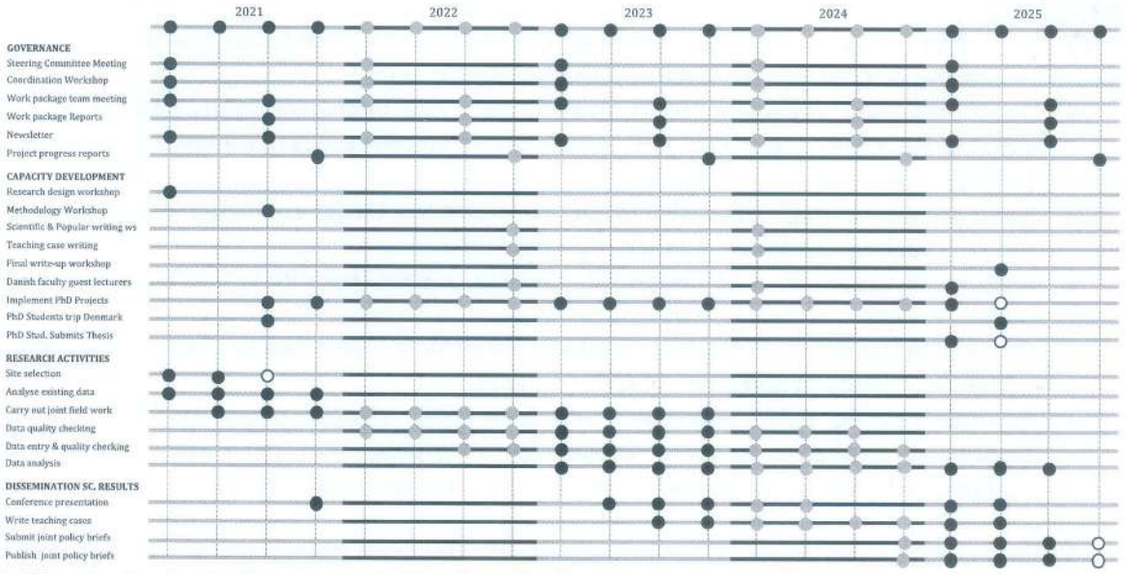


**Table 1. Project timeline. Solid dot designates repeated activities, hollow dots designates major project milestones.**

PACSMAC's governance structure ensures capacity development for team leaders and PhD students, who will be supervised throughout the project by two senior academic staff. Project members from either UDS or JU will serve as primary advisers, with secondary advising and mentoring responsibilities to be fulfilled by Northern partners in the respective students' WP. To ensure strong capacity building and collaboration, each WP will have at least two faculty from a Northern and at least two faculty from a Southern partner institution. Advisers will be responsible for ensuring students are exposed to the diverse disciplinary perspectives project members represent, are trained in relevant research methods and are able to take full advantage of networking and professionalization opportunities resulting from project meetings and workshops. Additionally, advisers will oversee their students' research, helping them select appropriate literature and supporting their cooperation with other team members in drafting their final research results.

**Organisation and Management**

A team of PACSMAC administrators composed of the project leader and a representative from each principal institution will be charged with management, monitoring

and financial reporting. Each principal institution bears responsibility for transparent, merit-based recruitment of all PhD candidates, with final selection to be determined by the project leadership. Project administrators will apportion responsibility for scientific and capacity-building oversight specifically to each WP phase.

The PACSMAC team is especially suited to carry out this project.

The Copenhagen Business School (CBS) is Denmark's largest educational and research institution with a focus on business administration and economics, broadly understood. The university provides business-related education programmes and continuing education for the public and, in particular, the private sector. As of 2020, it ranked fifteenth globally and eighth in Europe in Business & Management Studies (Quacquarelli Symonds). At CBS, PI Kristjan Jespersen is an expert in sustainability, climate change and commodity trade. Stefano Ponte is one of the top researchers in GVC analysis and in coffee markets. PhD candidate Juliane Lang has experience in intellectual property, intergovernmental organizations and agricultural VCs. Janina Grabs (incoming Assistant Professor, ESADE Business School) is an expert in sustainability governance in coffee VCs and Caleb Gallemore (Lafayette College) specializes in sustainable development, land-use and land-cover change, network analysis, and geospatial modelling.

The University of Dar es Salaam (UDSM) is the leading research institution in Tanzania, producing outstanding research results that range from high-quality publications and innovations to new technologies. The UDSM team will include a political ecologist with expertise in natural resource governance and politics (Christine Noe), a GIS and remote-sensing expert, also with experience in natural resource management (Kelvin Kamde), a geographer with extensive survey experience and expertise in forest and land rights and management (Asu Mwamfupe), a social network survey and analysis specialist (Pilly Silvano) and two PhD student with coffee and climate change expertise (TBD). The University has over 22,000 students in its certificate, diploma, postgraduate diploma, undergraduate and postgraduate programmes.

Jimma University (JU) is one of the largest public higher learning institutions in Africa with a history of progressive research, consecutively ranked at the top of Ethiopia's public universities. JU's International Institute of Coffee Research is dedicated to coffee science and covers diverse thematic areas. The university has strategic coffee research partnerships with KU Leuven, Wageningen University, the International Centre of Insect Physiology and Ecology (ICIPE) Kenya and Stockholm University. The team at JU will be based at the International Institute of Coffee Research, with skills and expertise across the social and natural sciences. Led by the Institute's director, Professor Gezahegn Yadessa, the team will also include a community agricultural outreach specialist (Shitaye Lemessa), a climate-smart coffee specialist (Weyessa Terefe), value chain and livelihood specialists (Adugna Bekele & Birki Gurmessa Toba) and two PhDs distributed across the WPs (TBD).

**Capacity Strengthening**

General capacity building : A variety of capacity building activities will be undertaken across all working groups, as follows:

1. Provision of and training in necessary computer software to project partners, including NVivo qualitative coding software, ArcGIS Pro, QGIS, Google Earth Engine, Python and R
2. Training in qualitative coding and policy document analysis techniques
3. Training in research project management and governance techniques

4. Training in time management and productivity techniques (PhD students only)
5. Training in writing for an academic audience (PhD students only)
6. Training in ethnographic, focus-group and semi--structured interviewing techniques (PhD students only)
9. Integration of project participants into relevant international networks, particularly the Food and Agricultural Organization of the United Nations (FAO), African Renewal, the African Union, the Consultative Group on International Agricultural Research (Under ICRAF and CATIE), The Sustainable Trade Initiative (IDH), Rainforest Alliance (RA), ISEAL Alliance, and Solidaridad.

**Partnerships**

The project aims to build partnerships through (1) integrating junior researchers and researchers from the Global South into relevant international research networks; (2) connecting with stakeholder organizations interested in coffee VCs; and (3) supporting South-South cooperation. PACSMAC researchers will present preliminary results and final papers at international conferences such as the Society for the Advancement of Socio-Economics, the International Studies Association, the International Society on Sustainable Development, and the Earth System Governance network. Select organizations such as the Earth System Governance network also allow junior researchers to become Research Fellows and participate in events such as early career researcher Winter Schools which are important for networking and idea incubation. PACSMAC will also strengthen existing ties to researchers at the International Center for Tropical Agriculture (CIAT) and the World Agroforestry Center (ICRAF). Through interviews, workshops, conferences and policy briefs, PACSMAC researchers also will engage with multi-stakeholder organizations such as the Initiative for Sustainable Trade, the initiative for coffee & climate, World Coffee Research, the Sustainable Coffee Challenge, the Global Coffee Platform, the Specialty Coffee Association and the African Fine Coffees Association, disseminating findings and exploring further potential collaboration. Finally, PACSMAC supports South-South cooperation, building close research partnerships between UDSM, the JU International Coffee Center and national/regional-level research networks such as the African Coffee Research Network (ACRN).

**Publication and Dissemination Strategy**

PACSMAC combines traditional and novel approaches to results dissemination. We anticipate 5-8 journal articles, all of which will be published open access. To reach a wider audience, project members will produce 3-4 summative policy briefs in English, Danish, Swahili and Amharic and conduct workshops in Addis Ababa, Dar es Salaam and Copenhagen. To the extent possible, all statistical analysis will be conducted using open-source software, and all analysis workflows, code and data will be made publicly available upon the publication of results. WP2 team members, in particular, will work to the extent possible to ensure these tools are accessible for adaptation and reuse by the environmental and governmental ministries for the three partner countries and the broader community. Finally, team members will further increase PACSMAC's relevance by drafting teaching cases in the above languages, which will be suitable for a higher education classroom setting. These cases will be freely available online through a Creative Commons BY license, which will also ensure greater engagement with PACSMAC's findings.

**List of References**

Bartlett, L., & Vavrus, F. (2016). *Rethinking Case Study Research: A Comparative Approach*. Taylor & Francis.

Bennett, A., & Checkel, J. T. (2014). Process Tracing: From Philosophical Roots to Best Practices. In A. Bennett & J. T. Checkel (Eds.), *Process Tracing: From Metaphor to Analytic Tool* (pp. 3–38). Cambridge ; New York: Cambridge University Press.

Beyersmann, J., Allignol, A., & Schumacher, M. (2012). *Competing risks and multistate models with R*. New York: Springer.

Bray, J. G., & Neilson, J. (2017). Reviewing the impacts of coffee certification programmes on smallholder livelihoods. *International Journal of Biodiversity Science, Ecosystem Services & Management*, 13(1): 216-232.

Bunn, C. (2019). Achieving climate-smart coffee in East Africa. Cali, Colombia: International Center for Tropical Agriculture (CIAT). https://cgspace.cgiar.org/handle/10568/103800

Bunn, C., Läderach, P., Rivera, O. O., & Kirschke, D. (2015). A bitter cup: climate change profile of global production of Arabica and Robusta coffee. *Climatic Change*, *129*(1–2), 89–101. https://doi.org/10.1007/s10584-014-1306-x

Bunn C, Lundy M, Läderach P, Fernández P, Castro-Llanos F. (2019). Climate-smart Coffee in Uganda. Cali, Colombia: International Center for Tropical Agriculture (CIAT). https://cgspace.cgiar.org/handle/10568/101331

Challies, E., Newig, J., & Lenschow, A. (2019). Governance for sustainability in telecoupled systems. In *Telecoupling*, ed. Friis, C., & Nielsen, J. Ø. New York: Palgrave. Pp. 177-197.

Craparo, A. C. W., Van Asten, P. J. A., Läderach, P., Jassogne, L. T. P., & Grab, S. W. (2015). *Coffea arabica* yields decline in Tanzania due to climate change: Global implications. *Agricultural and Forest Meterology*, 207: 1-10.

Eisenhardt, K. M. (1989). Building theories from case study research. *The Academy of Management Review*, *14*(4), 532–550. https://doi.org/10.2307/258557

Eisenhardt, K. M. (1991). Better stories and better constructs: the case for rigor and comparative logic. *The Academy of Management Review*, *16*(3), 620–627. https://doi.org/10.2307/258921

Fischersworring, B., Schmidt, G., Linne, K., Pringle, P., and Baker, P. (2015). *Climate Change Adaptation in Coffee Production. A step-by-step guide to supporting coffee farmers in adapting to climate change*. Hamburg: Coffee & climate. https://www.cabi.org/Uploads/CABI/projects/Coffee%20and%20climate%20change.pdf

George, A. L., & Bennett, A. (2005). *Case Studies and Theory Development in the Social Sciences*. Cambridge, Mass: The MIT Press.

Gereffi, G. (1994). The Organization of Buyer-Driven Global Commodity Chains: How U.S. Retailers Shape Overseas Production Networks. In G. Gereffi & M. Korzeniewicz (Eds.), *Commodity chains and global capitalism*. Westport: Greenwood Press. http://dukespace.lib.duke.edu/dspace/handle/10161/11457.

Gereffi, G. (1999). A Commodity Chains Framework for Analyzing Global Industries. Institute of Development Studies, 1–9.

Gereffi, G. (2014). Global value chains in a post-Washington Consensus world. Review of International Political Economy, 21(1), 9–37. https://doi.org/10.1080/09692290.2012.756414

Gereffi, G., Humphrey, J., & Sturgeon, T. (2005). The governance of global value chains. Review of International Political Economy, 12(1), 78–104. https://doi.org/10.1080/09692290500049805

Grabs, J., & Carodenuto, S. (under review). Traders as agents of sustainability governance in global food supply chains. A research agenda. R&R, Business Strategy and the Environment.

Grabs, J., & Ponte, S. (2019). The evolution of power in the global coffee value chain and production network. Journal of Economic Geography, early view. https://doi.org/10.1093/jeg/lbz008

Griffin, B. A., Ridgeway, G., Morral, A. R., Burgett, L. F., Martin, C., Almirall, D., Ramchand, R., Jaycox, L. H., McCaffrey, D. F. (2014). Toolkit for weighting and analysis of nonequivalent groups (TWANG) website. Santa Monica, CA: RAND Corporation. http://www.rand.org/statistics/twang.

Hirons, M., Mehrabi, Z., Gonfa, T. A., Morel, A., Gole, T. W., McDermott, C., et al. (2018). Pursuing climate resilient coffee in Ethiopia – A critical review. Geoforum, 91, 108–116. https://doi.org/10.1016/j.geoforum.2018.02.032

Howland, O., Brockington, D., & Noe, C. (2020). Women's Tears or Coffee Blight? Gender Dynamics and Livelihood Strategies in Contexts of Agricultural Transformation in Tanzania. *Agrarian South: Journal of Political Economy*, 2277976020925318.

International Coffee Organization (2019). Historical data on the global coffee trade. London: International Coffee Organization Website. http://www.ico.org/new_historical.asp?section=Statistics

Jaramillo, J., Muchugu, E., Vega, F. E., Davis, A., Borgemeister, C., & Chabi-Olaye, A. (2011). Some like it hot: the influence and implications of climate change on coffee berry borer (hypothenemus hampei) and coffee production in East Africa. PLoS ONE, 6(9). https://doi.org/10.1371/journal.pone.0024528

Kurose, S. (2019). Asians' love for instant coffee fuels robusta cultivation. *Nikkei Asian Review*, 06 October. https://asia.nikkei.com/Business/Markets/Commodities/Asians-love-for-instant-coffee-fuels-Robusta-cultivation2

Kweka, O. L., & Ouma, S. (2019). "Changing beyond Recognition"?: Reimagining the future of smallholder farming systems in the context of climate change. *Geoforum*.

Läderach, P., Ramirez–Villegas, J., Navarro-Racines, C., Zelaya, C., Martinez–Valle, A., & Jarvis, A. (2017). Climate change adaptation of coffee production in space and time. *Climatic Change*, *141*(1), 47–62. https://doi.org/10.1007/s10584-016-1788-9

Le Polain de Waroux, Y., & Lambin, E. F. (2013). Niche commodities and rural poverty alleviation: Contextualizing the contribution of argan oil to rural livelihoods in Morocco. *Annals of the Association of American Geographers*, 103 (3), 589–607.

Loc, V. T. T., Bush, S. R., & Khiem, N. T. (2010). High and low value fish chains in the Mekong Delta: Challenges for livelihoods and governance. *Environment, Development and Sustainability*, 12 (6), 889–908.

Mhando, D. G., & Mbeyale, G. (2010). *An analysis of the coffee value chain in the Kilimanjaro Region, Tanzania*. *NCCR North-South Dialogue*, 27.

Minten, B., Dereje, M., Engida, E., & Kuma, T. (2019). Coffee value chains on the move: Evidence in Ethiopia. *Food Policy*, 83: 370-383.

Mojo, D., Fischer, C., & Degefa, T. (2017). The determinants and economic impacts of membership in coffee farmer cooperatives: recent evidence from rural Ethiopia. *Journal of Rural Studies*, *50*, 84-94.

Mojo, D., Fischer, C., & Degefa, T. (2015). Social and environmental impacts of agricultural cooperatives: evidence from Ethiopia. *International Journal of Sustainable Development & World Ecology*, *22*(5), 388-400.

Neilson, J., & Shonk, F. (2014). Chained to development? Livelihoods and global value chains in the coffee-producing Toraja region of Indonesia. *Australian Geographer*, *45*(3), 269-288.

Neilson, J. (2019). Livelihood upgrading. In *Handbook on Global Value Chains*. Edward Elgar Publishing.

Otieno, H. M. O., Alwenge, B. A., & Okumu, O. O. (2019). Coffee production challenges and opportunities in Tanzania: The case study of coffee farmers in Iwindi, Msia and Lwati villages in Mbeya region. *Asian Journal of Agricultural and Horticultural Research*, 3(2). https://doi.org/10.9734/ajahr/2019/v3i229993

Ovalle-Rivera, O., Läderach, P., Bunn, C., Obersteiner, M., & Schroth, G. (2015). Projected shifts in coffea arabica suitability among major global producing regions due to climate change. *PLOS ONE*, *10*(4), e0124155. https://doi.org/10.1371/journal.pone.0124155

Pham, Y., Reardon-Smith, K., Mushtaq, S., & Cockfield, G. (2019). The impact of climate change and variability on coffee production: a systematic review. *Climatic Change*, *156*(4), 609–630. https://doi.org/10.1007/s10584-019-02538-y

Ponte, S. (2019). *Business, power and sustainability in a world of global value chains*. London: Zed Books.

Ponte, S., & Sturgeon, T. (2014). Explaining governance in global value chains: A modular theory-building effort. Review of International Political Economy, 21, 195–223. https://doi.org/10.1080/09692290.2013.809596

Ponte, S., & Ewert, J. (2009). Which way is "up" in upgrading? Trajectories of change in the value chain for South African wine. *World development*, *37*(10), 1637-1650.

Quiroga, S., Suárez, C., Diego Solís, J., & Martinez-Juarez, P. (2020). Framing vulnerability and coffee farmers' behaviour in the context of climate change adaptation in Nicaragua. *World Development*, *126*, 104733. https://doi.org/10.1016/j.worlddev.2019.104733

Richerzhagen, C., & Virchow, D. (2007). Sustainable utilisation of crop genetic diversity through property rights mechanisms: the case of coffee genetic resources in Ethiopia. International Journal of Biotechnology, 9(1), 60–86. https://doi.org/10.1504/IJBT.2007.012169

Ruben, R., Allen, C., Boureima, F., Mhando, D. G., & Dijkxhoorn, Y. (2018). *Coffee value chain analysis in the southern highlands of Tanzania*. Wageningen, Netherlands: Wageningen University.

Scoones, I. (2009). Livelihoods perspectives and rural development. *The journal of peasant studies*, *36*(1), 171-196.

Todo, Y., & Takahashi, R. (2013). Impact Of Farmer Field Schools On Agricultural Income And Skills: Evidence From An Aid-Funded Project In Rural Ethiopia. *Journal of International Development*, *25*(3), 362-381.

Todo, Y., Yadate, D. M., Matous, P., & Takahashi, R. (2011, March). Effects of geography and social networks on diffusion and adoption of agricultural technology: Evidence from rural Ethiopia. In *CSAE 25th Anniversary Conference*.

United States Department of Agriculture (2019). *Coffee: world markets and trade*. Washington, DC: United States Department of Agriculture, December 2019.

van der Vossen, H., Bertrand, B., & Charrier, A. (2015). Next generation variety development for sustainable production of arabica coffee (Coffea arabica L.): a review. *Euphytica*, *204*(2), 243–256. https://doi.org/10.1007/s10681-015-1398-z

Vicol, M., Neilson, J., Hartatri, D. F. S., & Cooper, P. (2018). Upgrading for whom? Relationship coffee, value chain interventions and rural development in Indonesia. *World Development*, *110*, 26–37. https://doi.org/10.1016/j.worlddev.2018.05.020

Yadessa, G. (2014). Genetic Diversity, Pollination Ecology and Organoleptic Characteristics of Coffea arabica L. in Ethiopian Moist Forests of Different Management Intensity.