www.snf.ch
Wildhainweg 3, Postfach 8232, CH-3001 Bern

Application form mySNF

Instrument **SPIRIT**

Part 1: General Information

Basic data

Project Title	Exploring the impact of climate change and urbanization on maternal and child health in Mozambique using digital data: the CliMaH project
Project title in English	Exploring the impact of climate change and urbanization on maternal and child health in Mozambique using digital data: the CliMaH project

Research Field	Mathematics, natural sciences
Main Discipline	30812 Methods of Epidemiology and Preventive Medicine
University	Universität Zürich - ZH

Applicant(s)

Main Applicant	**Andrea Farnham**
Other applicant(s)	Raushan Bokusheva Mirko Winkler Eusébio Victor Macete

Grant Application

Amount requested (CHF)	Total	**493'310**
Requested starting date	**01.09.2024**	
Duration (months)	**36**	

Attachments

Project Plan	SciencePart_Farnham.pdf Point_to_Point_notes_Farnham.pdf
CV and major achievements	CV_Farnham.pdf CV_Winkler_i01hf570wv4q2455s9nkdfnrc4r233.pdf CV_Bokusheva_SNSF_2023_complete61.pdf CV_Macete_i01hfedpr7zmkbjdm7g3mp5gytk2.pdf

1. Responsible applicant

Last name	**Farnham**
First name	**Andrea**
Function (title)	Senior Scientist
Academic degree	Dr./PhD
Date of birth	12.05.1986
Gender	female
Swiss social security number	756.1875.1998.22
Language	English
Nationality	United States of America
Correspondence address of application	Address of workplace

Home address

Address supplement	
Street, No.	Haldenweg 2
P.O. Box	
Postcode / Zipcode	5702
Place	Niederlenz
Country	Switzerland

Address of institute

Name of Institution 1 (e.g. laboratory) *	Department of Public and Global Health
Continuation 1 (e.g. inst /dept.)	EBPI
Continuation 2 (e.g. University)	University of Zurich
Street, No.	Hirschengraben 84
Address supplement 1 (e.g. building)	
Address supplement 2(e.g. office)	
P.O. Box	
Postcode / Zipcode	8000
Place	Zürich
State, canton, etc.	
Country	Switzerland

Communication

Secretariat line	+41 61 284 82 55
Switchboard	
Direct line	+41 61 284 86 84
Fax office	
Home telephone number	+41 79 486 62 77
Cellphone	+41 79 486 62 77
Website	https://andreafarnham.mystrikingly.com/
E-mail address	andrea.farnham@uzh.ch

2. Other applicants

General information

Last name	**Bokusheva**
First name	**Raushan**
Function (title)	
Academic degree	Prof. Dr.
Date of birth	03.03.1969
Gender	female
Language	German
Nationality	Germany
Correspondence address	Own home and working address

Home address

Address supplement	
Street, No.	Eidmattstr. 50
P.O. Box	
Postcode / Zipcode	8032
Place	Zürich
State, canton, etc.	
Country	Switzerland

Address of institute

Name of Institution 1 (e.g. laboratory) *	IUNR - Institut für Umwelt und
Continuation 1 (e.g. inst /dept.)	Natürliche Ressourcen
Continuation 2 (e.g. University)	
Street, No.	
Address supplement 1 (e.g. building)	Grüenthalerstr. 14
Address supplement 2(e.g. office)	GD211
P.O. Box	
Postcode / Zipcode	8820
Place	Wädenswil
State, canton, etc.	
Country	Switzerland

Communication

Secretariat line	+41 58 934 50 34
Switchboard	
Direct line	
Fax office	
Home telephone number	
Cellphone	
Website	
E-mail address	raushan.bokusheva@zhaw.ch

General information

Last name	**Winkler**
First name	**Mirko**
Function (title)	Professor of Urban Public Health
Academic degree	Dr./PhD
Date of birth	08.09.1977
Gender	male
Language	German

Nationality	Switzerland
Correspondence address	Enter my own working address

Address of institute

Name of Institution 1 (e.g. laboratory) *	Swiss TPH
Continuation 1 (e.g. inst /dept.)	Universität Basel
Continuation 2 (e.g. University)	
Street, No.	Kreuzstrasse 2
Address supplement 1 (e.g. building)	
Address supplement 2(e.g. office)	
P.O. Box	
Postcode / Zipcode	4123
Place	Allschwil
State, canton, etc.	BS
Country	Switzerland

Communication

Secretariat line	
Switchboard	
Direct line	
Fax office	
Home telephone number	
Cellphone	0612848339
Website	
E-mail address	mirko.winkler@swisstph.ch

General information

Last name	**Macete**
First name	**Eusébio Victor**
Function (title)	General Director
Academic degree	Dr./PhD
Date of birth	07.06.1967
Gender	male
Language	English
Nationality	Mozambique
Correspondence address	Enter my own working address

Address of institute

Name of Institution 1 (e.g. laboratory) *	Manhiça Health Research Centre
Continuation 1 (e.g. inst /dept.)	Manhiça Foundation
Continuation 2 (e.g. University)	
Street, No.	Rua 12, Cambeve
Address supplement 1 (e.g. building)	
Address supplement 2(e.g. office)	
P.O. Box	
Postcode / Zipcode	CP 1929
Place	Maputo
State, canton, etc.	
Country	Mozambique

Communication

Secretariat line	
Switchboard	
Direct line	
Fax office	
Home telephone number	
Cellphone	+ 258 21 810002
Website	
E-mail address	eusebio.macete@manhica.net

3. Applicants' employment

Information on employment and function at the anticipated starting date of the grant

Name	**Winkler, Mirko**
Employment at the anticipated starting date of the grant	permanent contract
Level of employment %	100
Function in the context of this grant application	Group leader, Senior physician
Professorship	Full professor
Doctorate (PhD)?	Yes
Date of doctorate (PhD)	27.05.2011
PhD supervisor	
Country of doctorate	Switzerland
Remarks	
Further employments	

Information on employment and function at the anticipated starting date of the grant

Name	**Bokusheva, Raushan**
Employment at the anticipated starting date of the grant	permanent contract
Level of employment %	100
Function in the context of this grant application	Senior scientist, Senior lecturer
Professorship	Professor at UAS / UTE
Doctorate (PhD)?	Yes
Date of doctorate (PhD)	24.12.1997
PhD supervisor	
Country of doctorate	Russia
Remarks	Habilitation at the ETH Zurich 01.02.2012
Further employments	

Information on employment and function at the anticipated starting date of the grant

Name	**Farnham, Andrea**
Employment at the anticipated starting date of the grant	fixed-term contract until
fixed-term contract until	31.12.2025
Level of employment %	80
Function in the context of this grant application	Senior scientist, Senior lecturer
Professorship	None
Doctorate (PhD)?	Yes
Date of doctorate (PhD)	10.11.2017
PhD supervisor	
Country of doctorate	Switzerland

Remarks	While I am on a fixed contract until 2025, the department head Prof. Dr. Jan Fehr (jan.fehr@uzh.ch) guarantees my salary and employment for the full duration of the grant.
Further employments	While I am on a fixed contract until 2025, the department head Prof. Dr. Jan Fehr (jan.fehr@uzh.ch) guarantees my salary and employment for the full duration of the grant.

Information on employment and function at the anticipated starting date of the grant

Name	**Macete, Eusébio Victor**
Employment at the anticipated starting date of the grant	permanent contract
Level of employment %	100
Function in the context of this grant application	Group leader, Senior physician
Professorship	Visiting professor
Doctorate (PhD)?	Yes
Date of doctorate (PhD)	02.01.2008
PhD supervisor	
Country of doctorate	Spain
Remarks	Dr. Macete was until recently Director of the Manhiça Health Research Center (CISM), and remains a senior investigator. Dr. Macete is also currently the General Manager of Farmacias de Moçambique Farmac SA.
Further employments	Dr. Macete is also currently the General Manager of Farmacias de Moçambique Farmac SA.

4. Project partners

General information

Last name	**Mananze**
First name	**Sosdito**
Function (title)	Deputy Dean for Research and Extension Affairs
Academic degree	Dr./PhD
Date of birth	11.09.1982
Gender	male
Language	English
Nationality	Mozambique

Address of institute

Name of Institution 1 (e.g. laboratory) *	School of Rural Development
Continuation 1 (e.g. inst /dept.)	
Continuation 2 (e.g. University)	Eduardo Mondlane University
Street, No.	
Address supplement 1 (e.g. building)	
Address supplement 2(e.g. office)	
P.O. Box	
Postcode / Zipcode	
Place	Maputo
State, canton, etc.	
Country	Mozambique

Communication

Secretariat line	
Switchboard	
Direct line	+258 84 2045113

Fax office	
Home telephone number	
Cellphone	
Website	
E-mail address	blessestevao@gmail.com

Contribution to the research project	Dr. Mananze will provide important guidance for the remote sensing work package. He has in-depth knowledge of environment, agriculture, and forestry within Mozambique, as well as methodological expertise in remote sensing techniques in the Mozambican context. He also has access to the most up-to-date ground truth data for agriculture in Mozambique.

5. Basic data I

Original title	Exploring the impact of climate change and urbanization on maternal and child health in Mozambique using digital data: the CliMaH project
Title in English	Exploring the impact of climate change and urbanization on maternal and child health in Mozambique using digital data: the CliMaH project
Requested starting date	01.09.2024
Duration (months)	36
Research field	Mathematics, natural sciences
Further research fields	Social sciences
	Medicine
Main discipline	30812 Methods of Epidemiology and Preventive Medicine
Sub-discipline(s)	20709 Other disciplines of Environmental Sciences
	30911 Public Health and Health Services

6. Basic data II

Summary	Climate change is transforming the world, and nowhere is this more evident than in Africa. Mozambique in particular has been subject to increasing extreme weather events, lessened agricultural productivity resulting in food insecurity and malnutrition, rapid urbanization and growth of informal settlements or slums, and a high public health burden of weather-related morbidity and mortality. The burden of the negative consequences of climate change fall most heavily on women and children. Despite growing understanding of the importance of this threat, a comprehensive, transdisciplinary, gender sensitive, governance oriented approach to studying the full impact of climate change on the well-being of human populations is still lacking, especially in combination with the rapid changes in urbanization in Mozambique. In the CliMaH project, we aim to integrate satellite and climate data with a mixed-methods on the ground study to (i) better understand how long-term population movement, trends in urbanization, changes in agricultural productivity, and demographic change link with climate change in Mozambique, (ii) study and predict how these trends affect the health of mothers and children in Mozambique, and (iii) develop a “road map” for impact assessment of climate change that uses a comprehensive methodological toolset (e.g. HIA, satellite data) and process (e.g. transdisciplinary stakeholder engagement), and can be generalized to other settings and time periods. The CliMaH project will have a special focus on generating evidence and solutions for policymakers and other actors outside academia. The project aims will be accomplished via five work packages (WP). In the first WP, we will use remote sensing data to characterize changes in land use and agriculture in Mozambique. In WP2, we will conduct a mixed-methods study in three to four climate change hotspots to study how climate change and urbanization trends affect maternal and child health outcomes. In WP3, we will model how climate, land use, and health are interlinked. Throughout the project, we will conduct stakeholder mapping and outreach to engage key actors outside of academia in the research, with the goal of establishing a long-standing multi-sectoral climate change consortium (WP4). Finally, we will synthesize the methodological and process innovations of this approach into a “road map” for climate change impact assessment that can be generalized to other settings globally (WP5). The study will have five key institutional partners (three in Switzerland, two in Mozambique) that represent the wide diversity of fields involved in climate change. Through an innovative, interdisciplinary approach to integrate digital data, participatory methods, social science, and environmental research, CliMaH will spearhead a shift in the climate change and disaster response paradigm to a more comprehensive intersectoral view, one that works with diverse stakeholders across disciplines to prospectively manage and predict emergent health issues due to the multifaceted effects of climate change and rapid urbanization.
Keywords	climate change
	health impact assessment
	maternal and child health
	remote sensing
Language of correspondence	German
Financial administration	Universität Zürich Finanzabteilung Fachstelle Drittmittel

7. Link to other SNSF projects

Link to other SNSF projets	yes
Application/Project	194003
Type of relationship	Connections CliMaH and HIA4SD projects: 1) Part of the partnerships of this application derive from the HIA4SD project. 2) During the implementation of the HIA4SD Project (2017-2023), many of the engaged stakeholders (e.g. Ministry of Health) expressed concerns about climate change and the impacts on health. This is part of the motivation for this application. Of note: End HIA4SD Project: 31 December 2023. Proposed start of the CliMaH Project: 1 September 2024. Hence, there is no overlap.

8. Re-submission

Project	216525
Remarks	In our first submission, Prof. Dr. Mirko Winkler was named as PI, with Dr. Andrea Farnham (postdoc) as project coordinator. CLiMaH was developed jointly by the two researchers, but Andrea Farnham was not yet in the position to be PI. In the last year, Andrea was promoted to the role of senior researcher, with the aim of setting up a research group on digital health in mobile populations. Therefore the new PI designation better reflects Andrea Farnham's leadership in the project.

9. University or research institution

University	Universität Zürich - ZH
Remarks	

10. Requested funding

Requested funding	**Total (CHF)**	**Year 1**	**Year 2**	**Year 3**
Total (CHF)	**493'310**	**182'655**	**204'879**	**105'776**

Equipment	**Total (CHF)**	**Year 1**	**Year 2**	**Year 3**
Material of enduring value, equipment	3'154	0	3'154	0
Total (CHF)	**3'154**	**0**	**3'154**	**0**
Total (%)	**1%**	**0%**	**2%**	**0%**

Research funds	**Total (CHF)**	**Year 1**	**Year 2**	**Year 3**
Travel	56'940	23'400	10'140	23'400
Conferences and workshops	21'500	6'000	3'000	12'500
Additional project costs (incl. consumables)	77'200	4'700	72'500	0
Total (CHF)	**155'640**	**34'100**	**85'640**	**35'900**
Total (%)	**32%**	**19%**	**42%**	**34%**

Salaries	**Total (CHF)**	**Year 1**	**Year 2**	**Year 3**
Salary for doctoral students	145'620	47'040	48'540	50'040
Salary for postdoc (employees with a doctorate)	33'120	8'280	16'560	8'280
Salary for further employees	119'260	74'939	40'271	4'050
Total (CHF)	**298'000**	**130'259**	**105'371**	**62'370**
Total (%)	**60%**	**71%**	**51%**	**59%**

Social security contributions	Total (CHF)	Year 1	Year 2	Year 3
Social security contributions	36'516	18'296	10'714	7'506
Total (CHF)	**36'516**	**18'296**	**10'714**	**7'506**
Total (%)	**7%**	**10%**	**5%**	**7%**

Allocation by person/project

Person	Total (CHF)	Year 1	Year 2	Year 3
Bokusheva, Raushan	60'375	60'375	0	0
	12%	33%	0%	0%
Farnham, Andrea	226'963	78'096	64'521	84'346
	46%	43%	31%	80%
Macete, Eusébio Victor	148'847	15'880	111'537	21'430
	30%	9%	54%	20%
Mananze, Sosdito	5'000	2'500	2'500	0
	1%	1%	1%	0%
Winkler, Mirko	52'125	25'804	26'321	0
	11%	14%	13%	0%
Total (CHF)	**493'310**	**182'655**	**204'879**	**105'776**

Details

Salary for doctoral students	Total (CHF)	Year 1	Year 2	Year 3
PhD student: geospatial analyses in health: n.n.	145'620	47'040	48'540	50'040
Work-time percentage	Year 1: 100.00% | Year 2: 100.00% | Year 3: 100.00%			
Social security contributions	Year 1: 15.00% | Year 2: 15.00% | Year 3: 15.00%			
Comments / Additions	The PhD student will conduct the geospatial epidemiological analyses, in particular the remote sensing analyses and the analysis of the quantitative data from the mixed-methods study, in partnership with the Mozambican data analysts. The PhD student will be part of the structured EBPhD program at the Epidemiology, Biostatistics, and Prevention Institute, and will be supervised by Dr. Andrea Farnham and Dr. Jan Fehr, the department head.			
Supervisor	Andrea Farnham			
Relation to person/project	Farnham, Andrea			
Total (CHF)	**145'620**	**47'040**	**48'540**	**50'040**
Total (%)	**30%**	**26%**	**24%**	**47%**

Salary for postdoc (employees with a doctorate)	Total (CHF)	Year 1	Year 2	Year 3
Mozambique data analyst, fieldwork coordinator: Herminio Cossa	33'120	8'280	16'560	8'280
Work-time percentage	Year 1: 25.00% | Year 2: 50.00% | Year 3: 25.00%			
Social security contributions	Year 1: 0.00% | Year 2: 0.00% | Year 3: 0.00%			
Comments / Additions	Herminio Cossa, PhD, will be a postdoctoral collaborator on the project at CISM. He will be responsible for the field data collection, and will provide expertise on qualitative and quantitative methods and maternal and child health in Mozambique. He will also work with the local ministry of health to extract and analyze DHIS2 and other governmental data. Note that the salaries given here correspond to the local normal salary ranges.			
Person	Herminio Cossa male / 09.07.1981			

	Number of children 2 / English / Mozambique			
Academic degree	Dr./PhD since 01.07.2021			
Relation to person/project	Macete, Eusébio Victor			
Start date doctoral thesis	Maternity, paternity, adoption or parental leave			
Total (CHF)		**33'120**	**8'280**	**16'560**	**8'280**
Total (%)		**7%**	**5%**	**8%**	**8%**

Salary for further employees		**Total (CHF)**	**Year 1**	**Year 2**	**Year 3**
Climate modeller: n.n.		52'500	52'500	0	0
Work-time percentage	Year 1: 33.00% | Year 2: 100.00% | Year 3: 100.00%				
Social security contributions	Year 1: 15.00% | Year 2: 15.00% | Year 3: 15.00%				
Comments / Additions	The postdoc or scientific collaborator will perform the climate modelling in partnership with Dr. Bokusheva, Dr. Farnham, and Dr. Nia Owen. They will have expertise in climate change modelling. The recruitment process will be gender sensitive.				
Relation to person/project	Bokusheva, Raushan				
Field workers: n.n.		13'333	0	13'333	0
Work-time percentage	Year 1: 0.00% | Year 2: 20.00% | Year 3: 0.00%				
Social security contributions	Year 1: 0.00% | Year 2: 0.00% | Year 3: 0.00%				
Comments / Additions	This budget line corresponds to the costs of hiring 10 fieldworkers in Mozambique for two months. The fieldworkers will conduct the mixed-methods study, including focus group discussions, interviews, and household surveys.				
Relation to person/project	Macete, Eusébio Victor				
Health data analyst/coordinator: Branwen Nia Owen		45'327	22'439	22'888	0
Work-time percentage	Year 1: 20.00% | Year 2: 20.00% | Year 3: 20.00%				
Social security contributions	Year 1: 15.00% | Year 2: 15.00% | Year 3: 15.00%				
Comments / Additions	Dr Nia Owen will do the project coordination, assist in the modeling of the health data, and integrate the findings into health impact assessment guidelines.				
Person	Branwen Nia Owen female / 29.10.1979 Number of children 2 / English / Ireland				
Academic degree	Dr./PhD since 01.05.2019				
Relation to person/project	Winkler, Mirko				
Mozambique Qualitative Health Researcher: Olga Cambaco		8'100	0	4'050	4'050
Work-time percentage	Year 1: 20.00% | Year 2: 20.00% | Year 3: 20.00%				
Social security contributions	Year 1: 0.00% | Year 2: 0.00% | Year 3: 0.00%				
Comments / Additions	Olga Cambaco will analyze the qualitative data and lend expertise on mixed methods studies in maternal and child health in Mozambique. Note that the salary corresponds with local norms in Mozambique.				
Person	Olga Cambaco female / 15.01.1991 Number of children 1 / English / Mozambique				
Academic degree	MSc since 26.10.2020				
Relation to person/project	Macete, Eusébio Victor				
Total (CHF)		**119'260**	**74'939**	**40'271**	**4'050**
Total (%)		**24%**	**41%**	**20%**	**4%**

Material of enduring value, equipment	**Total**	**Year 1**	**Year 2**	**Year 3**

	(CHF)			
Fieldwork equipment	3'154	0	3'154	0
Comments / Additions	Laptop, recorders, routers			
Relation to person/project	Macete, Eusébio Victor			
Total (CHF)	**3'154**	**0**	**3'154**	**0**
Total (%)	**1%**	**0%**	**2%**	**0%**

Travel	**Total (CHF)**	**Year 1**	**Year 2**	**Year 3**
Flights CH-Mozambique (incl. visa)	13'200	6'600	0	6'600
Comments / Additions	The Swiss research team will travel twice to Mozambique			
Relation to person/project	Farnham, Andrea			
Flights Mozambique-CH	13'200	6'600	0	6'600
Comments / Additions	The Mozambique applicants will travel twice to Switzerland			
Relation to person/project	Macete, Eusébio Victor			
Mozambique: internal flights	1'440	0	1'440	0
Comments / Additions	The Mozambique post-doc and/or research assistant will need to fly internally to conduct the fieldwork.			
Relation to person/project	Macete, Eusébio Victor			
Mozambique: internal stays	3'000	0	3'000	0
Comments / Additions	The Mozambique post-doc and/or research assistant will need to travel internally within Mozambique to conduct the field research.			
Relation to person/project	Macete, Eusébio Victor			
Mozambique: short term stays abroad	9'000	4'500	0	4'500
Comments / Additions	Mozambique applicants will travel twice to Switzerland			
Relation to person/project	Farnham, Andrea			
Short term stays in Mozambique	13'500	4'500	4'500	4'500
Comments / Additions	Hotels, meals, local travel for Swiss visits to Mozambique			
Relation to person/project	Farnham, Andrea			
Travels and accommodations within Switzerland	3'600	1'200	1'200	1'200
Comments / Additions	Short term research exchanges within the group and within Switzerland			
Relation to person/project	Farnham, Andrea			
Total (CHF)	**56'940**	**23'400**	**10'140**	**23'400**
Total (%)	**12%**	**13%**	**5%**	**22%**

Conferences and workshops	**Total (CHF)**	**Year 1**	**Year 2**	**Year 3**
Internal workshops	2'000	1'000	0	1'000
Comments / Additions	The costs include planning, Switzerland internal transportation, printing and stationary, and lunches.			
Relation to person/project	Farnham, Andrea			
International conference participation	2'500	0	0	2'500
Comments / Additions	Dr. Mananze and Dr. Cossa will identify an international conference to present study findings			
Relation to person/project	Macete, Eusébio Victor			
International conference participation	6'000	0	3'000	3'000
Comments / Additions	Dr. Winkler and Dr. Farnham and the PhD student will identify an international conference to present study findings.			

Relation to person/project	Farnham, Andrea			
Multi-stakeholder meetings		11'000	5'000	0	6'000
Comments / Additions	Two multi-stakeholder meetings will be held in Maputo. These costs include venue and organization, printing and stationary, translation costs, and communications.			
Relation to person/project	Farnham, Andrea			
Total (CHF)		**21'500**	**6'000**	**3'000**	**12'500**
Total (%)		**4%**	**3%**	**1%**	**12%**

Additional project costs (incl. consumables)		**Total (CHF)**	**Year 1**	**Year 2**	**Year 3**
Ethical clearance Mozambique		1'000	1'000	0	0
Comments / Additions	Amount needed to submit for ethical clearance in Mozambique				
Relation to person/project	Macete, Eusébio Victor				
Ethical clearance Switzerland		1'200	1'200	0	0
Comments / Additions	Amount needed to submit for ethical clearance in Switzerland				
Relation to person/project	Farnham, Andrea				
Household survey		70'000	0	70'000	0
Comments / Additions	These costs include development and printing of study materials, training of field workers, car rental for field research (3x cars for two months), rental of an office near fieldwork sites for transcription and translation, incentives for study participants, field supplies, communications materials, and snacks and water for study participants. This cost estimate is based on the experience gained in the frame of the HIA4SD Project.				
Relation to person/project	Macete, Eusébio Victor				
Laptops for remote sensing		5'000	2'500	2'500	0
Comments / Additions	Access to high-performance computing servers needed to handle the computing requirements for the remote sensing package.				
Relation to person/project	Mananze, Sosdito				
Total (CHF)		**77'200**	**4'700**	**72'500**	**0**
Total (%)		**16%**	**3%**	**35%**	**0%**

Social security contributions	**Total (CHF)**	**Year 1**	**Year 2**	**Year 3**
Climate modeller: n.n.	7'875	7'875	0	0
Health data analyst/coordinator: Branwen Nia Owen	6'798	3'365	3'433	0
PhD student: geospatial analyses in health: n.n.	21'843	7'056	7'281	7'506
Total (CHF)	**36'516**	**18'296**	**10'714**	**7'506**
Total (%)	**7%**	**10%**	**5%**	**7%**

11. Research requiring authorisation or notification

HRA-relevant and HRA-irrelevant research involving humans	Yes
Collection of data and/or samples	Yes
Authorisation ethics commitee	Will be submitted
Clinical trials of pharmaceutical products	No
Entry in the Swiss National Clinical Trials Portal (SNCTP)	Yes
Entry in SNCTP	not necessary
Use of existing samples or data	Yes
Authorisation ethics commitee	Will be submitted
In vivo somatic gene therapy	No
Ex vivo somatic gene therapy	No
Clinical trials with transplants	No

Research on human embryonic stem cells	No
Research on animals	No
Research on GMO or pathogens	No

12. 3R – Replace, Reduce, Refine

Project does not involve any animal experiments	Yes
Project involves experiments with animals that fall under the Animal Welfare Act (vertebrates, cephalopods, crayfish) and takes account of the 3R	No
Project is a 3R research project focusing on "Replace"	No
Project is a 3R research project focusing on "Reduce"	No
Project is a 3R research project focusing on "Refine"	No
Project involves experiments with animals that do not fall under the Animal Welfare Act (insects, worms)	No

13. Access and Benefit Sharing (ABS)

The research project plans to use genetic resources that are governed by the ABS provisions of the Nagoya Protocol	No

14. Fellowships for a research stay abroad

Project involves experiments that require authorisation and notification. I hereby confirm compliance with Swiss laws and ethical guidelines.	No

15. Awareness of the relevant regulations

Relevant regulations noted and accepted	Yes

16. General remarks on the project

Subject	
Communication	
Confidential	No

Exploring the impact of climate change and urbanization on maternal and child health in Mozambique using digital data: the CliMaH project

1. Summary (maximum 1 page)

Climate change is transforming the world, and nowhere is this more evident than in Africa. Mozambique in particular has been subject to increasing extreme weather events, lessened agricultural productivity resulting in food insecurity and malnutrition, rapid urbanization and growth of informal settlements or slums, and a high public health burden of weather-related morbidity and mortality. The burden of the negative consequences of climate change fall most heavily on women and children. Despite growing understanding of the importance of this threat, a comprehensive, transdisciplinary, gender sensitive, governance oriented approach to studying the full impact of climate change on the well-being of human populations is still lacking, especially in combination with the rapid changes in urbanization in Mozambique. In the CliMaH project, we aim to integrate satellite and climate data with a mixed-methods on the ground study to (i) better understand how long-term population movement, trends in urbanization, changes in agricultural productivity, and demographic change link with climate change in Mozambique, (ii) study and predict how these trends affect the health of mothers and children in Mozambique, and (iii) develop a "road map" for impact assessment of climate change that uses a comprehensive methodological toolset (e.g. HIA, satellite data) and process (e.g. transdisciplinary stakeholder engagement), and can be generalized to other settings and time periods. The CliMaH project will have a special focus on generating evidence and solutions for policymakers and other actors outside academia. The project aims will be accomplished via five work packages (WP). In the first WP, we will use remote sensing data to characterize changes in land use and agriculture in Mozambique. In WP2, we will conduct a mixed-methods study in three to four climate change hotspots to study how climate change and urbanization trends affect maternal and child health outcomes. In WP3, we will model how climate, land use, and health are interlinked. Throughout the project, we will conduct stakeholder mapping and outreach to engage key actors outside of academia in the research, with the goal of establishing a long-standing multi-sectoral climate change consortium (WP4). Finally, we will synthesize the methodological and process innovations of this approach into a "road map" for climate change impact assessment that can be generalized to other settings globally (WP5). The study will have five key institutional partners (three in Switzerland, two in Mozambique) that represent the wide diversity of fields involved in climate change. Through an innovative, interdisciplinary approach to integrate digital data, participatory methods, social science, and environmental research, CliMaH will spearhead a shift in the climate change and disaster response paradigm to a more comprehensive intersectoral view, one that works with diverse stakeholders across disciplines to prospectively manage and predict emergent health issues due to the multifaceted effects of climate change and rapid urbanization.

2. Research plan

2.1. Current state of research in the field

Climate change is a major growing threat to human health and well-being

Climate change is a threat to human development globally. The trend towards higher temperatures, changing rain patterns, and rising sea levels is intensifying, in particular across Africa (1). African countries experience some of the highest burden of the negative effects of climate change, despite their relatively low carbon footprints (1, 2). Across Africa, climate change is affecting food security, access to safe water, agricultural productivity, poverty levels, and public health (3). These are expected to have major effects on human health in the most affected regions, including increases in water and vector-borne diseases, increases in malnutrition due to the breakdown of food systems, death and illness from extreme weather events (e.g. heatwaves, floods), increases in mental health issues, and disruption of access to healthcare and basic infrastructure. The WHO estimates that by 2030, the direct health related costs of climate change will be between two to four billion US dollars annually (https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health). These issues can also lead to political and social consequences, such as conflict over scarce resources, increased numbers of climate refugees, and rapidly increasing rural-urban migration (4). Those who depend on agriculture, pastoralism, and fishing for their livelihood will be faced with increasing pressure to migrate, contributing to rapidly increasing urbanization . According to World Bank assessments, as many as 86 million Africans will migrate internally within their own countries by 2050 due to climate pressures (4).

Mozambique is particularly vulnerable to the environmental and social effects of climate change (5). The country has experienced the second highest sea-level rise in Africa (1). The increase in tropical cyclone frequency and magnitude in recent years has hit Mozambique particularly hard, causing internal population displacements (946,508 people as of September 2022) and an increase in weather-related mortality (1, 6). Over half of the country's population live in low-lying coastal areas, leaving them vulnerable to extreme weather events such as cyclones and flooding (5, 7). Increased flooding and drought cycles have put pressure on the agricultural sector, which employs approximately 80% of the Mozambique workforce (8). Central Mozambique has suffered from significant rainfall deficits, and is predicted to experience a significant drop in agriculture productivity due to droughts, floods, and bush fires (5). Meanwhile, northern and southern Mozambique have suffered from increased flooding, affecting food production (1). Increased food insecurity and malnutrition are already a problem (6). In addition, extreme weather events often cause outbreaks of water- and vector-borne diseases such as cholera and malaria (9). As climate change continues to intensify, Mozambique will face significant challenges in protecting the homes, livelihoods, and health of its people.

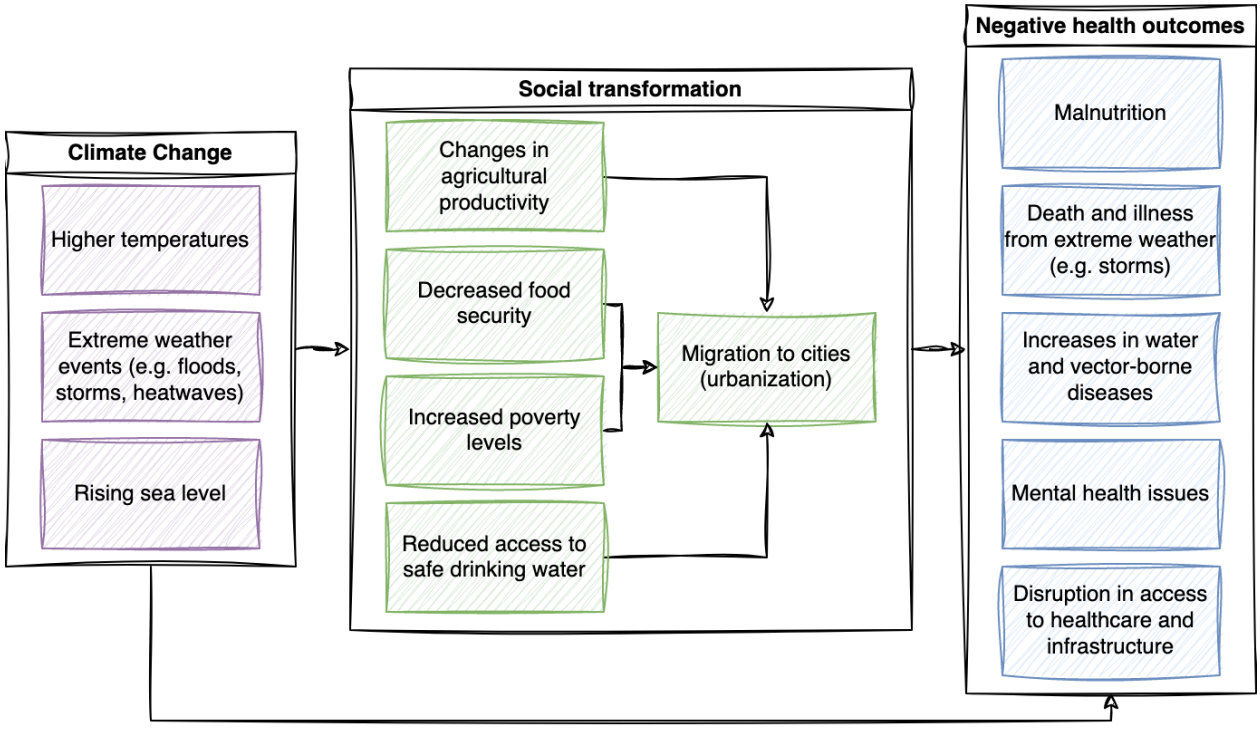

Figure 1. Conceptual overview of the direct and indirect pathways in which climate change impacts health. This includes social transformations, of which increasing urbanization plays an important role.

Women and children are particularly vulnerable to the effects of climate change

Research has shown that the impacts of climate change in low- and middle-income countries (LMICs) vary widely across socioeconomic classes, geographic regions, age groups, and gender. In particular, women are at greater risk of the negative effects of climate change due to economic, social, and cultural factors (7, 10). Globally, women represent the majority (70%) of those living in poverty (11). Women are highly active in agriculture globally, often in subsistence farming, but their productivity is weakened by a lack of access to resources and land (12). In addition, they have less access to education and formal employment, less decision-making power, and restricted mobility due to social norms and childcare duties, meaning their ability to adapt to changing conditions is more limited than that of men (7). The health consequences of climate refugees may be particularly acute for women and children. Both prenatal care and health outcomes after birth, including mental health issues, maternal mortality, and obstetric outcomes, are worse among migrant women (13-16). More research on the interactions between gender inequality, adverse health outcomes, and climate change is needed (17).

In Mozambique, women represent a particularly vulnerable group. Women in Mozambique already bear the highest burden of disease (e.g. a rate of HIV infection three times higher than that of men in some age groups (7)). Thus far, only limited research has been done on the interaction between gender inequality and climate change in Mozambique, but one study suggested that women and men are affected differently due to imbalances in power and differentiated roles (18). Women in Mozambique also have the potential to become highly effective agents of climate change mitigation and adaptation strategies. For example, they have historically been responsible for managing household resources such as water and food. However, to harness the positive power

of female climate leadership and promote adaptive capacity among women in LMICs, women's needs and demands need to be a central part of climate change policies and actions. So far, despite the creation of legal instruments such as the National Gender Policy and the Gender Strategy for the Agrarian Sector, Mozambique's governance has not proposed actionable measures towards a gender sensitive approach to climate change response (18).

Climate change is driving urbanization patterns in Sub-Saharan Africa

Among the most important effects of climate change are the ways in which it is changing migration and urbanization patterns in LMICs. The drying of Africa in the last fifty years has increased migration from rural to urban areas, but local effects on urban centers depend strongly on the structural characteristics of those cities (19). Healthy cities can be important drivers of the national economy, but care must be taken to mitigate the negative environmental, social, and health effects of rural-urban migration while promoting sustainable development (20). The health impacts of migration related to climate change can include psychosocial ill health, exposure to environmental risks at the destination, reduced access to healthcare services, food insecurity, and inadequate water and sanitation (21).

Mozambique is currently urbanizing at a rapidly accelerating rate (22). Most urban dwellers live in informal settlements or slums, where they are exposed to greater environmental and health risks than in planned settlements (7). Often informal settlements are characterized by poor-quality dwellings and resource scarcity, and they are often located in flood plains or other areas susceptible to further climate disasters (22). Research from informal settlements in Beira, a large city in the central region of Mozambique, has shown that rapid urbanization and growth of informal settlements has increased inequality in access to water and sanitation services, especially among the poorest communities (23). Importantly, data indicate that the majority of people living in informal settlements in Mozambique are women (20). Access to resources such as water, sanitation, transportation, and electricity is often inconsistent and of low quality, making these communities vulnerable to extreme weather events and waterborne diseases (7, 20). To protect the health and well-being of the most vulnerable members of society, along with promoting sustainable economic growth, policymakers in Mozambique need to increase participatory urban planning in areas currently experiencing dynamic population growth.

Digital data and health impact assessment methods offer new urban planning solutions

Climate change has provoked a tremendous rural-urban migration in Africa (24, 25). The lack of policies and actions for lessening the impact of climate change on livelihoods of rural populations and for monitoring and governing migration processes poses an immense threat to health and well-being in many African countries, and Mozambique in particular (24). These threats affect most heavily women and children (17). However, the mechanisms of climate change impacts on rural-urban migration remains largely unstudied; it may be driven by changes in livelihood or availability of agricultural land (25). This hampers the development of effective measures of climate change and climate-change induced migration governance. In order to promote sustainable

urbanization by encouraging resilient communities, designing adequate infrastructure, and preventing the formation of slums, policymakers need new evidence and tools (25). This gap in tools has long been driven by a lack of data. As satellite imagery availability has become almost universal in LMICs and resolution has improved, especially the ecological and agricultural fields have begun utilizing satellite data to track changes in land use (26, 27). These data can also be used to understand population shifts in rapidly changing areas in LMICs, which is of crucial importance for public health services and planning. Organizations like WorldPop have made geo-located population datasets based on these satellites and other digital data methods in LMICs publicly available (28). This population data can be combined with detailed, geo-located health data such as Demographic and Health Surveys (DHS) and District Health Information Software (DHIS2) to create spatial maps of health over time (29-35). Researchers have the ability to ask more detailed questions than ever before about relationships between population demographics, health indicators and health determinants such as household wealth and education. While satellite data has been used widely in tracking agricultural productivity, including in Mozambique (27), these datasets have not yet been used for tracking climate change and associated health effects in vulnerable population groups over time in a more comprehensive way.

Beyond new data sources, participatory, intersectoral approaches to understanding the effects of climate change are necessary in order to develop and implement effective climate change mitigation and adaptation strategies. The health impact assessment (HIA) approach offers an evidence-based toolbox to develop strategies to prevent and mitigate negative health effects of climate change and rapid urbanization (36). Therefore, HIA is considered a central methodology for promoting healthy cities (37). A particular strength of HIA is that it promotes the combination of quantitative and qualitative methods to create a holistic understanding of potential health consequences of projects, policies, or specific events, such as climate change and rapid urbanization. Moreover, HIA pays particular attention to the identification and inclusion of vulnerable groups with the objective to reduce health inequalities (38). For this purpose, HIA applies participatory approaches such as focus group discussions and in-depth interviews, allowing community members to have an active role in shaping resilience and adaptation planning. Exactly this is currently often missing in current climate change risk management strategies, including in Mozambique (22).

Summary of knowledge gaps and overarching research objectives

While we know that climate change is a major growing global threat to health, ecology, environment, agriculture, livelihoods, urban studies, governance, and gender inequity, researchers often do not collaborate across disciplines to address these linked threats in a comprehensive way (39-42). Furthermore, despite the common knowledge of the particular vulnerability of women and children to the effects of climate change, there is still only limited research that specifically targets the needs of these groups (10, 18). In addition, until relatively recently, in-depth data on shifts in land use, population change, urbanization rates, and health indicators have been scarce (26, 28, 43-54). In combination, these challenges have meant that the development and

implementation of gender-sensitive, effective climate change mitigation and adaptation strategies have lagged far behind needs in Mozambique and in Africa at large.

In this project, we aim to integrate satellite and climate data with a mixed-methods on-the-ground study to (i) better understand how long-term population movement, trends in urbanization, changes in land use, and demographic change link with climate change in Mozambique, (ii) study and predict how these trends affect the health of mothers and children in Mozambique, and (iii) develop a "road map" for impact assessment of climate change that uses a comprehensive methodological toolset (e.g. HIA, satellite data) and process (e.g. multi-sectoral stakeholder engagement), and can be generalized to other settings and time periods. The CliMaH project (full title: Exploring the impact of climate change and urbanization on maternal and child health in Mozambique using digital data) will have a special focus on generating evidence and solutions for policymakers.

2.2. Current state of your own research and partnership aspect

The CLiMAH partnership was born from longstanding research collaborations within the Urban Public Health Unit (formerly HIA Research Group) at Swiss TPH, an internationally recognized centre of excellence in HIA research and capacity building (38). This success is grounded in continuous research efforts (since 2008) exploring connections between large infrastructure developments, urbanization and health across sub-Saharan Africa. Of particular relevance to the proposed project is the HIA4SD Project (Health Impact Assessment for Sustainable Development; 2017 – 2023; https://hia4sd.net/), funded under the SNSF Research for Development (r4d) programme. The HIA4SD Project examines population health outcomes associated with large natural resource extraction projects in sub-Saharan Africa (55), and has a major focus on the patterns of urbanization and migration around mines. Within HIA4SD, Prof. Dr. Mirko Winkler and Dr. Andrea Farnham supervised six PhD students coordinating 181 focus groups and 325 key informant interviews performed over 13 field sites in Mozambique, Burkina Faso, Ghana, and Tanzania (55). In that project Dr. Farnham directed geospatial modelling to determine how mines affect health determinants, morbidity and mortality patterns in local communities (29, 30, 32, 33, 56, 57). We also gained expertise in how the new DHIS2 data platform could be used to examine trends in population health over time, with Dr. Farnham authoring two publications on the use of these data (31, 33). Through this work, we forged a particularly strong partnership with the Manhiça Health Research Centre (CISM) and the Ministry of Health in Mozambique. Our colleagues Dr. Herminio Cossa and Olga Cambaco (both CISM) worked closely with us on projects related to maternal and child health in Mozambique (58-60).

After the completion of her work on the HIA4SD project, Dr. Farnham moved to the Epidemiology, Biostatistics, and Prevention Institute (EBPI) at the University of Zurich (UZH). At the EBPI Dr. Farnham works as a senior researcher, with the aim of building her own research group on digital health in highly mobile populations. She brings considerable methodological expertise in digital data and spatial analyses (49, 61-65) to incorporate new digital and data-driven methods into the project. Her work with satellite data began during HIA4SD, when she supervised a PhD student on an analysis using machine learning and remote sensing data to classify land use over time in the areas around mines (66). Dr. Farnham then successfully obtained an additional grant in 2022

(University of Basel Forschungsfond) to extend these methods to using digital data to track migration in Northern Mozambique after the recent humanitarian crisis (MIGRANTh project). Together with a computer science student, she developed methods using Google Earth Engine and machine learning to classify changes in land use and urbanization after the cyclones and conflict in northern Mozambique (first author Dr. Farnham, publication submitted to the journal Remote Sensing).

Through her work on remote sensing, Dr. Farnham formed a partnership with Prof. Dr. Sosdito Mananze at the Eduardo Mondlane University (UEM) in Mozambique. Prof. Dr. Mananze has expertise in characterizing changes in land use and agriculture using satellite data (27), as well as in urban studies. He will bring invaluable contextual knowledge and access to agricultural data.

Within MIGRANTh we partnered with Prof. Dr. Raushan Bokusheva at the Zurich University of Applied Sciences (ZHAW), Institute of Natural Resource Sciences, who has extensive expertise in modelling the climate change impact on agriculture productivity and land use. Prof. Dr. Bokusheva leads several projects analyzing climate change impact on agriculture (68) and investigating options for effective management of risks of extreme events in agriculture (69, 70).

Gender strategy and promotion of women's health and rights

The CliMaH project aims to promote gender equity in both the research team and the research content. The research team was carefully composed to be gender balanced in its senior leadership (n=2 women PIs, n=2 men PIs) and mid-level researchers (n=2 women, n=1 man). A gender conscious recruitment process will be conducted for the PhD student and postdoc at ZHAW on the project (i.e., caregiver bias will be explicitly avoided and a clear target defined that the overall project team remains at least 50% women or non-binary individuals). In addition, a gender awareness workshop will be conducted as part of the first internal workshop at project kickoff, prior to new employee recruitment or field research. At the conclusion of this workshop, the study team will be introduced to a structured mentoring plan supporting junior researchers in developing a personalized career development plan, with a special emphasis on the needs of women researchers. As part of the mentorship program, junior researchers will be connected with a senior researcher outside of the project that matches their area of interest, in addition to mentorship within the project. Junior researchers will also be connected with UZH-based transferable skills trainings on the necessary soft skills for their career progression, such as strengthening networking and communication, resolving conflict, and overcoming research-related barriers.

CliMaH will apply a gendered lens to measuring the social and health transformations that accompany a changing climate. It is well established that gender affects vulnerability, ability to adapt, inequities in health outcomes, and ability to effect social action (7,10), but real world evidence lags far behind. In the CliMaH project, we aim to follow the theoretical and conceptual framework of gender analysis of attitudes and adaptation mechanisms to climate change in the context of Sub-Saharan Africa laid out by Dr. Nagasha et al in 2019 (72). This conceptual framework is underpinned by established theories of gender socialization, role constraint, intra-

household decision making and institutional theories. During the gender awareness workshop during the project kickoff, this framework will be revisited and adapted together with the full project team for the Mozambican context, as well as extended to include gender differentiated health consequences of climate change. Our aim is to take an intersectional approach that avoids dichotomization into man versus woman or a victimization discourse, and instead provides insight into the complex ways that social and political realities intersect in Mozambique to empower or disenfranchise individual abilities to respond to the ongoing climate crisis.

2.3. Detailed outline of planned research

In Mozambique, there has been a gap in interdisciplinary, gender sensitive approaches to climate change research and mitigation and adaptation strategies. By approaching climate change with an interdisciplinary paradigm (see Figure 1), and integrating new data sources with participatory HIA approaches, we aim to form a new research toolbox centered around predicting and monitoring maternal and child health needs in the era of climate change. The ultimate aim is to provide actionable solutions for existing governance structures. The research aims of the CliMaH project correspond to five work packages (WP), each of which comes with a distinct methodological approach as described in detail in the following sub-chapters.

WP1. Remote sensing: using remote sensing data to characterize changes in land use and urbanization.

WP2. Mixed-methods study to investigate how climate change and urbanization trends affect maternal and child health outcomes.

WP3. Modelling of trends in climate change, land use and health.

WP4. Stakeholder engagement to translate research into actionable solutions.

WP5. Road map for climate change impact assessment: development of a generalizable methodological toolset and process for addressing impacts of climate change on maternal and child health.

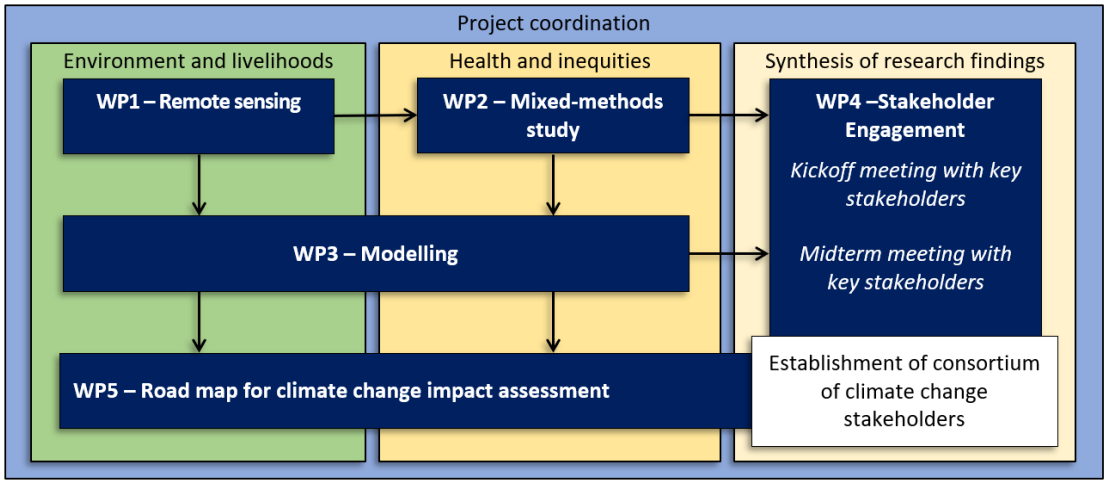

Figure 2. Overview of study WPs.

2.3.1. Methods

The proposed CliMaH project is a mixed-methods, multi-stage study that takes a multi-sectoral approach to evaluating and responding to the multidimensional effects of climate change and urbanization in Mozambique. Each WP is led by a different discipline, and each subsequent WP builds on the findings of the previous WPs. In a first step, we use satellite data to track changes in land use over the last decade (WP1). The mapping will be used to identify highly dynamic areas are currently affected by changes in climate (e.g. by land abandonment, growth in peri-urban landscapes, increased rural-urban migration). These areas will then be the sites of a participatory, mixed-methods study combining quantitative data on incidence of health indicators with the voices and insights of the affected women themselves (WP2). In a third step, we will use the results from the mapping along with many other sources (see Table 1) to establish a retrospective panel study modelling how climate and land use have changed over the past decade in Mozambique (WP3). We will engage with external stakeholders in the form of workshops and advisory boards at regular points throughout the CliMaH project in order to continuously translate WP findings into actionable solutions (WP4). Finally, results of all WPs will be synthesized and formalized into a "road map" for climate change impact assessment aimed at predicting and monitoring maternal and child health needs in the era of climate change.

WP1. Remote sensing.

Climate change has a transformative effect on the ecology of tropical regions, and understanding how land use (e.g. agriculture, urban) has changed has important implications for managing resources such as water and food production (73). To understand which regions have been most affected by climate change, it is important to be able to quantify how land use has already changed and identify the key trends across regions, particularly in urbanization rates. This WP will take advantage of remote sensing methods developed in the agricultural and environmental fields to quantify how land use and urbanization has changed over the last decade and produce national level digital maps of vulnerabilities in different climate dimensions.

Specific research questions: (1) How and where has Mozambique land use changed the most in the last 10 years? (2) Where has urbanization been growing most rapidly? (3) What are the longitudinal changes in land use both nationally and regionally over the last ten years?

Methods and data: This WP uses publicly available satellite data from both Landsat 8 OLI/TIRS (early years) and/or Sentinel – 2 A/B MSI (later years) covering Mozambique between 2013 and 2023 to characterize changes in land use, urbanization, and agriculture over this time period. These satellites are chosen due to the high number of bands available and the high spatial and temporal resolution. Each province will be characterized separately in an annual composite image after image pre-processing for radiometric, geometric corrections and cloud masking. Large urban centers such as Maputo will be analyzed separately to be able to examine the growth of informal settlements on a more granular level. For all images, key vegetation indices (e.g. normalized difference vegetation index (NDVI)) and texture metrics (e.g. contrast) will be computed, similarly to previous studies in Mozambique (27). The final image composite will be created by aggregating the images for each scene

for that year using the median pixel value. Training and validation data will be selected from historical Google Earth imagery and classified according to six classes: natural vegetation, water bodies, agriculture, bare soils, grassland, and urban. The number of validation points will be set to at least 30% of the training points.

The optimal combination of input features for the classification algorithm will be selected separately for each province and map, due to the potentially differing climatic conditions. Different combinations of bands, indices, texture metrics, and window sizes will be considered in accordance with previously developed methodologies (27). The Jeffreys–Matusita distance (JM), a measure of class separability, will be computed for each combination and used to select the combination of input features that achieves the highest separability of the landcover classes. After selection of the input features, we will use the random forest (RF) classifier algorithm within Google Earth Engine to classify land use in each scene to the six classes. To assess the accuracy of the classification, we will compute a confusion matrix and conduct an accuracy assessment of each map. The overall accuracy (OA), Kappa coefficient (KC), producer accuracy (PA), and consumer accuracy (CA) will be calculated and used to evaluate the quality of the maps. We will then calculate percentage changes in different land use classes over time by region. Regions of high change will be identified and studied on a more granular level. Results will be compared to governmental data, WorldPop data, and statistics where available. Results will also be compared to coarse resolution MODIS satellite automated classification data to see how the accuracy compares with that from satellites with reduced resolution. Areas of rapid urbanization will be identified.

Collaborators: This work draws on an existing collaboration between Dr. Farnham and Prof. Dr. Mananze (UEM), who have already partnered to map land use change in Cabo Delgado in the wake of the 2019 cyclones and civil unrest. Prof. Dr. Mananze previously used machine learning and satellite data to characterize changes in smallholder farming and agricultural productivity in regions in Mozambique. The PhD student at EBPI will develop these analyses, co-supervised by Dr. Farnham and Prof. Dr. Mananze.

Outcomes and outputs: Scientific publications on how land use has changed in Mozambique (at least two), maps of climate change vulnerability, and identification of highly dynamic hotspots, which sets the basis for WP2, the mixed-methods study.

WP2. Mixed methods study.

In addition to quantitatively understanding changes on a national level, it is important to understand on a granular level who the affected populations are (e.g. women, adolescents, minority groups, certain professions), their reasons for migrating in or out of highly dynamic regions, and their own views on how climate change and urbanization have affected their health. It is key to understand the role that vulnerable groups such as women, children, and refugees play in the impact of and response to climate change. To fully address these questions, both quantitative approaches (i.e., health surveys) and qualitative approaches that incorporate the direct perspectives of women affected by climate change (i.e., focus groups, key informant interviews) are essential.

Specific research questions: (1) From their own perspective, what are the most important health issues of women and their children due to climate change, rapid urbanization, and changes in agriculture? (2) How do health and well-being concerns differ in sites affected by different types of climate change (e.g. drought, coastal erosion)?

Methods and data: The methods for this mixed-methods, interdisciplinary WP are divided into three distinct parts: (1) quantitative household surveys in areas strongly affected by climate change, (2) a qualitative study incorporating individual perspectives on health outcomes associated with different migratory groups, and (3) triangulation of these approaches to identify synergies and discrepancies in the quantitative and qualitative results. We will obtain ethical clearance in both Switzerland and Mozambique in partnership with our health partners at CISM. Fieldwork will be conducted in the three to four most important rapidly urbanizing sites identified in WP1. In recruiting for this study, we will specifically target risk factors and needs of the vulnerable populations where the burden of adverse effects of climate change-related urbanization is highest.

Household surveys will be conducted based on clustered random sampling in the identified fieldwork sites. Approximately 400 households will be sampled per site. This number is based on a conservatively estimated prevalence of 30% of households in these regions being affected by climate related changes such as migration or urbanization and a study attrition rate of 20%, which yields an expected sample size of 404 (calculated using 95% confidence and 5% margin of error within the Scalex SP sample size calculator). Households will be eligible if there is at least one child aged under five years living in the household. Surveys will be conducted with the mother of the child. A standardized questionnaire adapted from the DHS template will be used to better understand the health, migration background, livelihood, and household composition of a representative sample of households in rapidly urbanizing areas.

Key informant interviews and focus group discussions will be conducted with the populations identified to be most at risk. Key informant interviews will be conducted with local leaders (e.g., government officials, church leaders) knowledgeable about the needs of local women and children; focus group discussions will be conducted with women from local communities in rapidly urbanizing areas. Participants in each site will be identified based on purposive sampling guided by local gatekeepers (e.g. community leaders). Approximately 30-40 key informant interviews (ten per site) and 18-32 focus group discussions (six to eight per site) will be conducted, as previous experience has shown that this is enough to reach saturation (74). The focus group discussions will provide opportunities to raise awareness of gender-based inequities in the community, and the discussions sparked will guide the discussion of key obstacles and enablers to gender sensitive mitigation strategies. The transcripts will be imported into NVivo software for qualitative data analysis to code the transcripts for thematic content and framework analysis.

The quantitative and qualitative findings will be triangulated (i.e. compared and contrasted) to highlight synergies and discrepancies in findings, analyze the insights and limitations of both data sources, and generate new hypotheses.

Collaborators: This WP will draw on the strong health and inequity research partnership between Dr. Farnham at EBPI, Prof. Dr. Winkler at Swiss TPH, and Dr. Macete, Dr. Cossa and Olga Cambaco at CISM in Mozambique. Dr. Cossa and Olga Cambaco have a strong background in maternal and child health research and qualitative research, and will be responsible for conducting the fieldwork and analyzing the data in partnership with EBPI and Swiss TPH. The PhD student at EBPI will be responsible for analyzing the quantitative data in collaboration with Dr. Cossa.

Outcomes and outputs: Scientific publications on how climate change and urbanization have affected health, gender-based inequities, and migration choices (at least two); identification of most pressing health issues; opportunity to raise gender awareness in the field

WP3. Modelling.

To understand how health and health determinants are associated with climate change in Mozambique, it is key to be able to describe major trends in climate, land use, and urbanization in the country as a whole, and understand how population health indicators have changed in these highly dynamic regions. WP3 takes a quantitative approach to model the relationships between these key trends using panel data approaches, and produce national level digital maps of vulnerabilities in these four dimensions. In previous projects (e.g. HIA4SD, MIGRANT^{h}), we identified that indicators related to maternal and child health are the most high quality and consistently collected data in routine surveillance (i.e. DHIS2 data). In addition, national level surveys such as DHS have a strong emphasis on indicators related to maternal and child health.

Specific research questions: (1) How do climatic extreme events such as tropical cyclones (e.g. related to flooding and windspeed damage) correlate with changes in land use, urbanization, and smallholder farming? (2) What are the longitudinal changes in key maternal and child health indicators in areas most affected by climate change in the last 20 years, including rapidly urbanizing areas? (3) What is the relationship between land use, food supply/access, urbanization and trends in maternal and child health indicators in Mozambique?

Methods and data: This is an ecological modelling study constructing a large database of population, health and health determinant outcomes using mainly publicly available public data (see Table 1) to determine population level changes associated with climate change indicators. This panel study will link weather and land use data over the last decade in Mozambique, and model how climate change is associated with population movement and corresponding agricultural and health effects.

Routine meteorological and tropical cyclone data will be obtained from the International Best Track Archive for Climate Stewardship (IBTrACS) provided by the National Oceanic and Atmospheric Administration. This meteorological raw data will then be deployed in a hydrodynamic flood and meteorological wind field model to generate damage measures of spatial destructiveness. Next, geo-located data on a wide range of health and health systems indicators related to especially to maternal and child health will be extracted longitudinally at

high resolution in the regions characterized as highly affected by climate change (see Table 1 for all data sources that will be utilized, and Table 2 for key health outcomes).

Table 1. Quantitative data sources used in WP3.

Data Source	Abbreviation	Description	Data frequency	Data Quantity
WorldPop Country Datasets	WorldPop	Spatial demographic datasets for Central and South America, Africa, and Asia	Yearly	100m resolution
Landsat 8 OLI/TIRS	Landsat	Earth observation satellite data	Same scene every 16 days	30m resolution
Sentinel 2 A/B MSI	Sentinel 2	Earth Observation satellite data	5 days	10, 20 m resolution
International Best Track Archive for Climate Stewardship	IBTrACS	Routine meteorological and tropical cyclone data from National Oceanic and Atmospheric Administration	Daily	Ca. 10 km
Demographic and Health Survey	DHS	Nationally representative household surveys that provide information on a wide range of health, population, and nutrition indicators.	Usually every 5 years (last conducted 2022)	5,000 to 30,000 households per round
Service Availability and Readiness Assessment	SARA	A health facility assessment survey designed to monitor service readiness and availability indicators.	Conducted in 2018	Every health facility in the country
Malaria Indicator Survey	MIS	Household survey designed to collect information on a wide range of malaria indicators.	Every 3-5 years (last conducted 2018)	5,000 to 30,000 households per round
Multi-Indicator Cluster Survey	MICS	Household survey designed to collect data on indicators related to the situation of children and women.	Every 5 years (last conducted 2018)	5,000 to 30,000 households per round
District Health Information Software	DHIS2	Open source software platform to collect, manage, and visualize routine health information by health facility and district across Sub-Saharan Africa	Monthly, quarterly, or yearly, depending on indicator	Available by health facility and aggregate at health district level

Table 2. Health outcomes considered as part of the quantitative study. All data can be spatially and temporally disaggregated: DHIS2 to health facility or district level; DHS to the household level (within 10km). DHIS2 is usually available monthly, while DHS is available every 3-5 years.

Health outcome indicators	Health determinant indicators
STI incidence per 1,000 persons per year (source: DHIS2 data)	Number and distribution of health facilities per 10,000 population (source: SPA and SARA data)
Stunting and wasting rate among children <5 years (source: DHS data)	Vaccination coverage in children aged <5 years (source: DHS and DHIS2 data)
Maternal deaths per 100,000 live births (source: DHS and DHIS2 data)	Proportion of births attended by skilled personnel (source: DHS and DHIS2 data)
Under-five mortality rate, incl. perinatal mortality rate and stillbirth rate (source: DHS and DHIS2 data)	Wealth index (source: DHS)
Low birth weight rate (source: DHS and DHIS2 data)	Education and literacy levels (source: DHS)
Caesarian section rate (source: DHS and DHIS2 data)	Housing quality (source: DHS)
Pediatric healthcare utilization (outpatient and inpatient) (source: DHIS2 and SPA data)	Water and sanitation infrastructure (source: DHS)

Malaria incidence per 1,000 person per year (source: DHS and DHIS2 data) (source: DHS and DHIS2 data)	Number of women completing one and four antenatal care visits (source: DHS and DHIS2 data)
Acute respiratory disease in children <5 years (source: DHS and DHIS2 data)	
Diarrhea rate in children <5 years (source: DHS and DHIS2 data)	

Health facilities (or household clusters in the case of DHS data) will be 'geomatched' using QGIS to the identified highly affected areas in a spatial merging step to create a large longitudinal panel of regional socioeconomic characteristics, health infrastructure, and health outcomes. This data, combined with the WorldPop population data, has already been used to successfully map childhood vaccination coverage, poverty, and gender-disaggregated development indicators. We will take similar approaches to map these indicators (45, 52, 75, 76). The modelling of climate data will take a similar approach to previous work by our collaborator Prof. Dr. Bokusheva's group, and will focus primarily on the rainfall and flooding impact of tropical cyclones (71).

Collaborators: This WP will be a partnership between Dr. Farnham, who has expertise in health modelling, the PhD student at EBPI, modeler Dr. Branwen Nia Owen at Swiss TPH, and Prof. Dr. Bokusheva and a postdoc at the ZHAW, who have expertise in modelling climate change impact on land use and agricultural productivity to understand how region-specific rural-urban migration patterns and climate have already changed. Dr. Mananze will provide key contextual expertise. Dr. Cossa will aid in the extraction and analysis of the DHIS2 data in partnership with the Mozambique Ministry of Health.

Outcomes and outputs: Scientific publications on how climate and land use change has affected trends in health indicators, health determinants, and gender-based inequities (at least one); scientific publications on links between climate and land use (at least one); spatial mapping of climate-related vulnerabilities in the different dimensions studied; creation of a large geo-linked database for climate change research.

WP4. Stakeholder engagement.

Translating evidence from research into effective climate change adaptation strategies and "Healthy Cities" policies requires continuous engagement with local authorities and decision-makers. Therefore it is of the highest importance that this project creates a coalition of key involved stakeholders outside of academia starting from the onset of the project. In the final phase of the CliMaH Project, we will explore the establishment of a a multi-sectoral climate change consortium to institutionalize the evidence-based development of climate change adaptation strategies in Mozambique. This is also a key opportunity to introduce a gender lens to the thinking of policymakers within Mozambique.

Specific research questions: (1) Who are the key agencies, decision-makers, and involved stakeholders in climate change response and urban planning in Mozambique? (2) How can we best increase the visibility of our findings outside of the academic community? (3) What are the governance barriers for implementation of climate change adaptation strategies and "Healthy City" policies?

Methods and data: This WP will begin at the onset of the project with a comprehensive mapping of the institutions and stakeholders involved in climate change and urban planning governance at the national level (e.g. research groups, politicians and policymakers, government health officials, private sector companies, and NGOs). The results of this mapping exercise will be an important input into the design of the analytical process that follows, as well as the stakeholder engagement throughout the research project. This workshop will serve the multiple purposes of allowing study design to be driven by the needs of local policymakers, informing key stakeholders of emerging findings, and incorporating stakeholder feedback into the ongoing study. Gender awareness will be a key topic at the workshop, and local experts in women's rights will be asked to conduct a session on why gender sensitive climate adaptation and city planning strategies are key to achieving success in the Mozambican context. Key actors will be asked to be part of an advisory board for the study, and will be invited to a kick-off workshop and mid-term workshop to give feedback on preliminary findings and provide expertise to shape the research design. In the final stage of the project, the advisory board and a wider array of actors will be invited to be part of a climate change and urbanization consortium. During a final workshop, the key results of the study will be presented to the multi-sectoral climate change consortium using a co-creation approach to form a final report, with emphasis on actionable steps for governmental and international bodies on how they can mitigate the negative effects of climate change and urbanization on women and children. This final report will be developed into a policy brief.

Collaborators: This WP will be a collaboration between the expertise of ZHAW and the already existing networks of Dr. Farnham, Prof. Dr. Winkler and Dr. Macete in Mozambique. Dr. Farnham has strong existing connections with researchers in Mozambique. Prof. Dr. Winkler (fluent in Portuguese) has already participated in consortia related to mining in Mozambique, and has a network including public and private actors. Dr. Macete has strong connections with the various Ministries in Mozambique, especially the Ministry of Health.

Outcomes and outputs: Policy brief; establishment of a Mozambican multi-sectoral climate change consortium; new governance model to predict and manage evolving threats in a timely and effective way.

WP5. Road map for climate change impact assessment.

In a final step, we aim to synthesize the methods developed during the study into a "road map" for climate change impact assessment, where the methodological toolsets (e.g. satellite data on land use changes, urbanization patterns, geospatial databases using DHIS2 and DHS data, and weather modelling, participatory, gender sensitive HIA approaches) and processes (e.g. engagement between research findings and external stakeholders) will be integrated into a comprehensive approach that can be followed by the multi-sectoral climate change consortium after study conclusion. This road map will be able to be adapted to diverse settings across Africa and potentially other world regions.

Specific research question: How can the methods and processes used in this study be standardized to form a new toolbox for studying the intersectoral, gender differentiated effects of climate change and urbanization in other settings?

Methods and data: In a final stage of the CliMaH project, the entire study team will meet for an internal multiday workshop to develop a formalization of the final methodology and processes in a collaborative way. This methodology will then be developed into a methods publication, and incorporated into HIA teaching materials, including guidelines on how to incorporate an intersectional gender lens into climate change and urbanization research. As part of this WP, team members will also reach out to new countries and funding agencies to implement the road map in settings beyond Mozambique.

Collaborators: This WP will be a collaboration of the methodological expertise of all involved partners, led by the HIA expertise of Prof. Dr. Winkler at Swiss TPH and Dr. Farnham at EBPI.

Outcomes and outputs: Methods publication; incorporation of new methods into HIA training.

2.3.2 Risk management plan

Risk	Mitigation Strategy
Some types of urbanization may be difficult to link quantitatively with climate change (medium risk)	Rural-urban migration has many causes, and climate change may be only one of those causes. On an ecological level, causal links may be difficult. However, the addition of the on the ground mixed methods study will provide additional causal evidence and context for the quantitative findings of WP1. By triangulating the qualitative and quantitative findings, this risk will be mitigated.
Classification of land use using remote sensing may be more accurate in some regions than other regions (medium risk)	Due to previous research using a similar approach to map agriculture in Mozambique, we know that the approach outlined here is highly likely to be successful in mapping similar regions of Mozambique (27). While more arid regions may be more difficult to classify (66), most of Mozambique is tropical and therefore easier to classify accurately. In addition, the results of the first WP will provide valuable evidence on which regions are most suitable for these methods across Africa.
Conflict and weather extremes in Cabo Delgado (medium risk)	In choosing fieldwork sites, we will take into consideration the possibility for conflict or weather extremes (e.g. cyclones) disrupting the fieldwork, and plan the fieldwork for times of year when these risks are likely to be low. We will preferentially choose sites that have not recently been the site of conflict.
Health and population data not at sufficiently high resolution to track changes in highly dynamic areas (low risk)	By incorporating a variety of large quantitative data sources (Table 1), this risk is mitigated. In addition, we will consider the quantity and quality of available data in the region while selecting the sites for fieldwork and more in-depth research.
Political and cultural sensitivity, especially when related to potentially controversial health risks such as violence or mental health (low risk)	We have the advantage of drawing on the deep social science expertise of our partners at CISM, including on addressing sensitive public health topics with women and adolescents. In addition, we plan on hiring local fieldworkers who have contextual knowledge to support the local PhD student with the qualitative research after he or she is hired.

2.4. Collaboration, work division, schedule, milestones and visits

	Year 1				Year 2				Year 3				Milestones
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
WP1: Remote sensing													
Processing and analyzing satellite imagery			M1										M1: Identification of climate change hotspots
Producing digital maps				M2									M2: Creation of maps of climate change vulnerability
Publication of results					M3								M3: Publication of methods, climate change maps
WP2: Mixed-methods study													
Preparation of ethics submission				M4									M4: Ethics approval obtained (WPs 2 &3)
Identification of study sites				M5									M5: Final study sites identified
In-country training of fieldworkers													M6: Final dataset produced
Fieldwork: household surveys, focus groups, interviews													M7: Quantitative publication(s) relating associations between climate change, urbanization, maternal and child health and determinants
Transcription and translation of qualitative data							M6						
Analysis & triangulation of quantitative and qualitative results													M8: Qualitative and mixed-methods publications on the female perspective on the effects of climate change and urbanization
Publication of results									M7			M8	
WP3: Modelling													
Creation/analysis of geolinked database					M9								M9: Creation of final geolinked database from all extracted data
Modelling environmental effects of climate change													M10: Publication of analysis linking climate change, land use, and population change
Modelling health effects of population and climate change													
Creation of vulnerability maps													M11: Publication of analysis linking climate change, population movement, and subsequent health effects
Publication of results						M10			M11				
WPs4 & 5: Stakeholder engagement & Road map for climate change impact assessment													
Co-creation workshops with external stakeholders		M12										M13	M12: Establishment of advisory board
Internal workshops	V1	V2					V3				V4	V5	M13: Establishment of climate change consortium
Publication of results												M14	M14: Publication of policy brief

Planned visits (1 week each): (V1) Dr. Macete, Dr. Mananze, and Dr. Cossa will visit Switzerland for the project planning meeting; (V2) Dr. Winkler, Dr. Farnham, and Dr. Bokusheva will visit Mozambique for the kickoff workshop; (V3) Dr. Winkler, Dr. Farnham, and Dr. Bokusheva will visit Mozambique for one week for the stakeholder workshop; (V4) Dr. Macete, Dr. Mananze, and Dr. Cossa will visit Switzerland to synthesize research findings with full team; (V5) Dr. Winkler, Dr. Farnham, and Dr. Bokusheva will visit Mozambique for final stakeholder workshop.

2.4.1 Research team and partner institutions

Our team includes investigators and study partners from five key institutions: the Epidemiology, Biostatistics, and Prevention Institute (EBPI) at the University of Zurich (UZH), the Swiss Tropical and Public Health Institute (Swiss TPH), the Zurich University of Applied Sciences (ZHAW), and the Manhica Health Research Centre (CISM), and the Eduardo Mondlane University (UEM) in Mozambique. Our team is a mix of senior (n=5) and junior researchers (n=3).

Andrea Farnham, PhD, **(PI)** is a Senior Researcher at the EBPI at the UZH, where she leads research on digital health and mobile populations. Her previous projects have focused on innovating epidemiological studies with digital data sources and methodologies, and especially collaborating across disciplines. She has supervised 8 PhD students and 4 MSc students from 7 countries in four studies. She will be the overall coordinator of the project, as well as co-supervise the PhD student, direct and conduct the analytical approach, and provide expertise on digital data and health.

Mirko Winkler, PhD, is Professor in Urban Public Health at the Swiss TPH, where he leads the Urban Public Health Unit. With his substantial track record in inter- and trans-disciplinary research projects, Prof. Dr. Winkler will be the co-PI of the CliMaH Project. He willlead the health impact assessment work package and contribute his expertise in HIA, environmental epidemiology, qualitative and quantitative field data collection, and stakeholder engagement processes. He will co-coordinate the CliMaH Project in close collaboration with Dr. Farnham.

Eusebio Macete, MD, PhD, (co-PI) is former director of CISM and plays a major role in public health research in Mozambique. His long track record of successful project implementation includes many projects related to maternal and child health, including a Bill and Melinda Gates funded project exploring mental health in Mozambican mothers (https://www.centreforglobalmentalhealth.org/catalyst-better-mental-health-for-young-mozambican-mothers-0). He has a long-standing collaboration with the project team, as he was also a co-PI on the HIA4SD project with Prof. Dr. Winkler and on the MIGRANT^{h} project with Dr. Andrea Farnham.

Sosdito Mananze, PhD, is the Deputy Dean for Research and Extension Affairs and Assistant Professsor of Remote Sensing of Agriculture and Natural Resources at the Escola Superior de Desenvolvimento Rural at the UEM. He has long-standing expertise in remote sensing data, urban studies, and agricultural system monitoring in Mozambique, with previous grants including Earth Observation for Africa (EO4Africa). In his function as a project partner of the CliMaH Project, he will provide expertise on the use of remote sensing to track changes in land use and agriculture over time and modelling environmental change in Mozambique.

Raushan Bokusheva, PhD, is a Professor at ZHAW and head of the Agricultural and Resource Economics Research Group. She has long standing expertise in exploring the role of policies and impacts of innovations on sustainability and productivity in food supply chains. In her role as co-PI, Prof. Dr. Bokusheva will lead the task on modelling of the effects of climate change on land use and rural livelihoods.

Branwen Nia Owen, PhD, will be the coordinator and analytical support of the study at Swiss TPH. She will do project planning and support the modelling of health data in WP3.

Herminio Cossa, PhD, will be a postdoctoral collaborator on the project at CISM. He will be responsible for the field data collection, and will provide expertise on qualitative methods and maternal and child health in Mozambique.

Olga Cambaco, MSc, will be a social scientist on the project at CISM. She has expertise in utilizing mixed methods approaches in exploring child and adolescent health in Mozambique, and will analyze the qualitative data.

A **PhD student** with expertise in spatial epidemiology will be recruited to the project at EBPI. They will conduct the remote sensing analysis within Google Earth Engine, as well as integrate and analyze the health data. They will be part of the structured Epidemiology and Bioststatics PhD program, co-supervised by Andrea Farnham and Prof. Dr. Jan Fehr, department head at EBPI.

A **postdoctoral** collaborator will be recruited to the project at ZHAW. They will provide expertise on modelling using climate and environmental data.

2.5. Relevance and impact

Climate change is one of this century's most prominent, increasingly pervasive public health events and is projected to affect LMICs in Africa most strongly. Understanding the full impact of climate change on the well-being of human populations requires evidence and collaboration between diverse fields: environment, ecology, agriculture, economics, governance, and public health. The CliMaH Project will spearhead a shift in the climate change and disaster response paradigm to a more comprehensive, intersectoral view that engages interdisciplinary researchers and local stakeholders to prospectively manage and predict emergent health issues due to the multifaceted effects of climate change, including urbanization in the global south. Through our innovative inter- and transdisciplinary research approach, we will demonstrate how digital data, climate change modelling, participatory methods, and environmental research can be integrated to give affected populations – with special attention to mothers and children – more agency in managing their health by improving access to decision-making bodies. Until now, concepts of climate change response have focused mainly on top-down support from international bodies in the wake of major disasters, an approach that is ineffective in building resilience and adaptation in an era of constant change. This new approach to climate research shifts the focus towards generating prospective climate change adaptation strategies in partnership with multiple stakeholders, in line with the Health Cities approach. By focusing on both national level data and qualitative research that draws directly on the experiences of the most vulnerable populations, CliMaH will contribute new evidence towards improved adaptation strategies and policy. The reliance on mainly publicly available data and innovative analyses means that CLiMaH has the potential to revolutionize how LMICs inform policy decisions

by using inexpensive and effective digital solutions to track climate change and urbanization, enabling them to design public health interventions specific to regional needs.

In addition to the contribution of new evidence to understand the burden of climate change, CliMaH represents considerable methodological innovation. Integrating digital data at an ecological level and primary data from epidemiological mixed-methods studies will generate new hypotheses in climate change and health research, allowing researchers a more comprehensive, detailed view of the climate change and urbanization phenomenon in LMICs . Results will be published both in peer-reviewed scientific journals and conference proceedings. We will also communicate results directly to key stakeholders in Mozambique in the form of workshops, consortia, and policy briefs. Finally, methodological innovations will be immediately implemented to train a new generation of researchers as part of the regular, international HIA trainings conducted by the HIA group. Importantly, CliMaH will also orient its findings beyond the academic community, providing a long-lasting blueprint for collaboration in the form of establishing a multi-sectoral climate change consortium and a road map for action on climate change.

Contribution to the achievement of the 2030 SDG Agenda and gender equity in climate change adaptation

Despite the known threat of climate change to sustainable development, decision-making bodies continue to lag behind in providing sustainable solutions for mitigation and adaptation. The CliMaH project addresses this gap, integrating several disciplines into a new approach to climate change research: health, environment, society, and economy. Through the interdisciplinary setup, the outcomes and findings of our study will not only contribute to SDG 13 (Climate Action), but also SDG 3 (Good Health and Well-Being), SDG 5 (Gender Equality), SDG 10 (Reduced Inequalities), SDG 11 (Sustainable Cities and Communities), and SDG 2 (Zero Hunger). Importantly, the project will also build strong relationships between research and governance (SDG 17: Partnership for the Goals). Finally, by conducting solution oriented research that follows a transdisciplinary approach and engages stakeholders from multiple sectors up from the beginning, the CliMaH project embraces several strategies that are considered essential for advancing the 2030 Agenda and its 17 SDGs by means of research partnerships (77).

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Point-by-point response: Resubmission of CliMaH project

We wish to resubmit our project after substantial revisions based on the reviewer feedback from last year. We thank the three reviewers for their overall positive appraisal of our work, and providing specific feedback where we could improve the CliMaH project. We specify the major changes below.

- **Research team: Change of principal investigators (PIs).** In our first submission, Prof. Dr. Mirko Winkler was named as PI, with Dr. Andrea Farnham (postdoc) as the project coordinator. As mentioned in the original submission, CLiMaH was developed jointly by the two researchers, but Andrea Farnham was not yet in the position to be a PI. In the intervening year, Andrea moved to a new institute and was promoted to the role of senior researcher, with the aim of setting up a research group on digital health in mobile populations. Therefore the current PI designation better reflects Andrea Farnham's leadership in developing the project from the beginning. It is also fully in line with the SPIRIT mandate to promote the creation of a gender balanced applicant group and support young researchers. A PhD student will do much of the analytical work, so this project now supports a young female researcher in developing her own research group. Responding to reviewers' comments about the lack of expertise in maternal and child health (MCH), **Dr. Eusebio Macete, director of the Manhiça Health Research Centre in Mozambique, now participates as co-PI.** Dr. Macete has more than 20 years of health research expertise in Mozambique, particularly in implementing MCH studies. To comply with the consortium composition rules, the consortium agreed that Dr. Sosdito Mananze will serve as project partner, with Dr. Natasha Ribeiro providing expertise as needed, in the resubmission.
- **Additional expertise in MCH methods and approaches**: The reviewers pointed out that the MCH component could be further developed. Two new team members with extensive expertise in MCH in the Mozambican context now strengthen project-based competencies in MCH. Dr. Eusebio Macete will be a new co-PI, responsible for the overall implementation of the MCH component. Olga Cambaco, a social scientist in health with in-depth experience conducting MCH research in Mozambique, joins the team to conduct the analysis of the qualitative data through a gender lens. Additionally, we expanded Table 2 to more closely detail the health outcomes and determinants considered (e.g. Low birth weight rate was added, under-five mortality rate was expanded to specify perinatal mortality rate and stillbirth rate, which (as the reviewer pointed out) are important, globally-accepted indicators that accessible from both DHIS2 and DHS). Finally, to make the methodology more explicit, the proposed source of data for each indicator was included in parentheses in Table 2.
- **Addition of a well-elaborated MCH and women's health and rights section**: To address the concern about a lack of a separate MCH and women's health and rights section, we added a section (pages 7-8) detailing the overall gender equity strategy of both the research team composition and the methodological approach. As part of this comprehensive strategy, the project staff recruitment plan has been detailed, including a gender awareness workshop at the project start and implementation of a mentoring plan for women researchers. We also adopt a conceptual framework that has been elaborated for a gender lens in the context of climate change in Sub-Saharan Africa, while acknowledging that very little has yet been done in this field in the context of Mozambique, especially in health.
- **Sample size justification**: We made more explicit the calculations behind our sample size calculation (page 11). There is very little previous research to base our sample size calculations on; therefore, we estimated very conservatively to ensure adequate power based on previous household studies we have conducted.
- **Higher visibility of gender awareness in the research content:** We added a guiding conceptual framework around MCH in the CliMaH project, as detailed above. We also added details in WP2 on how the qualitative research can be used to guide the introduction of gender awareness into the field research, and spark important conversations in the community on gender sensitive adaptation strategies (p. 12). We also recognized that WP4 on

Stakeholder Engagement is a key opportunity to introduce a gender lens to conversations by policymakers on the national level by explicitly including gender awareness as part of the stakeholder workshop (p. 15). Finally, we expanded on the CliMaH project contributions to HIA practice by adding that the methods should explicitly spell out new guidelines for how HIA practice can routinely introduce a gender lens into climate change research (p. 16).

- **Relative importance of climate change to health**: In response to a reviewer comment that the link between climate change to health could be better developed, we added an explicit list of the expected effects of climate change on health to the introduction (p. 2), as well as a conceptual diagram (p. 3).
- **Defining remote sensing methodology**: We acknowledge that there was some lack of specificity in the original project plan on whether we were mapping, "changes in land use" vs. "changes in population movement." Strictly speaking, we cannot directly estimate population movement from satellite imagery, only indirectly through the change in urban land use categories or reductions in agricultural land. To triangulate data sources and create indirect estimates of population movement, however, we can compare our land use change results with Worldpop data estimating population in Mozambique from satellite images (among other sources). Nevertheless, because the main objective of WP1 is to develop methods using satellite imagery, we revised the project plan to only reference estimating changes in land use with the satellite imagery. We also specified that we will use both Landsat and Sentinel imagery in the project, with Landsat imagery being used before Sentinel imagery became available. A reviewer noted we did not include forest in our land use categories, only natural vegetation. Here we did not add forest as a separate category, per our experience and the advice of our local agriculture and forestry expert Prof. Dr. Mananze. Mozambique is a tropical climate and it is virtually impossible to differentiate forest from the other types of natural vegetation that occur. Our classifications follow those found in the existing literature on land use classification in tropical settings. Finally, we deleted our planned comparison of the selection of input features across climatic zones. The main intent of this analysis was to identify whether the methods were more suitable to certain climatic zones or areas. We agree with the reviewer that it is not the main aim of the WP. We also deleted that we would use ground truth data where available, as the availability of these data vary widely by region and time period. We agree with the reviewer that these data are not as reliably available as simply using historical Google Earth imagery. We made it clear that the remote sensing analysis is one of the main projects of the PhD student on the project, to be co-supervised by Dr. Farnham and Prof. Dr. Mananze.
- **Methodology of mixed-methods study (WP2):** We added more details to the following: (1) the characterization of likely populations affected by climate change and urbanization, (2) explanation of the triangulation methods, (3) specification of data sources, methodologies, and spatial and temporal resolution.
- **Further integration of urbanization into the study methods**: One reviewer commented that much of the methods are centered around climate change, and less so urbanization. Our view is that climate change is one of the main drivers of urbanization, so the two are inextricably linked. We made this link more explicit in the introduction (p. 2-3) and offered theories as to why rural-urban migration is occurring (i.e. loss of livelihood and agricultural land), while noting that this is understudied. We also added a conceptual diagram showing the theorized causal pathway between climate change, urbanization, and health (p. 3). Within each WP, we ensured that exploring the effects of urbanization was explicitly integrated into the methods and research questions. It is also worth mentioning that co-PI Prof. Dr. Winkler is a Professor of Urban Public Health, so brings substantial expertise in urban studies to the project.
- **Stakeholder engagement:** We agree with the reviewer's excellent point that the methods contribute more to climate change adaptation than mitigation. We deleted mention of climate change mitigation in this setting.

- **Problems with causal inference in ecological modeling:** we agree with reviewer two that it would be problematic to use our ecological data to say that climate change "caused" migration or urbanization and associated health outcomes, just as it is impossible to say that a storm yesterday was caused by climate change. That is one reason why we aim to collect data from multiple sources, to create a unique larger picture of how climate and urbanization and health trends are shifting in Mozambique over the last decade. For example, the climate change modeling will describe whether increases in flooding and extreme weather events are temporally associated with rapid changes in land use or the size of urban areas, and how it differs over the country. Through our mixed methods study, we will also directly link these quantitative changes with the voices of affected populations themselves. We believe that this will paint a more complete picture of the gender and demographic specific effects of the changes associated with climate change in Mozambique than has previously been possible, independent of the causal link between an individual's situation and climate change. We also note that we report this as part of our risk management plan on p. 16. To further make this explicit, we have also removed causal language in the modelling WP, instead stating that we will model trends in climate change, land use, and health.

CV

Andrea Farnham
Academic age: 4 year(s) 9 month(s)

Education

Degree	Organisation	Duration
PhD / Dr.: Doctoral degree in Epidemiology and Biostatistics Prof. Dr. Christoph Hatz, Prof. Dr. Milo Puhan	Universität Zürich - ZH, CH Epidemiology, Biostatistics and Prevention Institute (EBPI)	08.2014 - 11.2017 3 year(s) 4 month(s)
Master: Masters in Public Health	Columbia University, US Mailman School of Public Health	09.2010 - 05.2012 1 year(s) 9 month(s)
Bachelor: Bachelor of Arts	Tufts University, US Double major Biology and Spanish	09.2004 - 05.2008 3 year(s) 9 month(s)

Employment

Role	Organisation	Duration
Senior researcher	Universität Zürich - ZH, CH Epidemiology, Biostatistics and Prevention Institute (EBPI), Department of Public and Global Health	03.2023 - 12.2025 2 year(s) 10 month(s)
Junior researcher / Postdoc Prof. Dr. Mirko Winkler	Schweizerisches Tropen- und Public Health-Institut - Swiss TPH, CH Department of Epidemiology and Public Health	11.2017 - 03.2023 5 year(s) 5 month(s)

Role	Organisation	Duration
Research associate / Scientific collaborator Dr. Jennifer Rosen	New York City Department of Health and Mental Hygiene, US Bureau of Immunization Surveillance Unit	07.2012 - 06.2014 2 year(s)
Research associate / Scientific collaborator Dr. Sharon Balter	New York City Department of Health and Mental Hygiene, US Bureau of Communicable Disease Foodborne Diseases Unit	08.2011 - 06.2012 11 month(s)
Research associate / Scientific collaborator Dr. Eddy Perez-Then	Centro Nacional de Investigaciones en Salud Materno Infantil, DO Maternal and Child Health Research	05.2011 - 08.2011 4 month(s)
Research associate / Scientific collaborator Dr. Ellen Perrin, Dr. Radley Christopher Sheldrick	Tufts Medical Center, US Pediatrics	08.2008 - 08.2010 2 year(s) 1 month(s)

Major achievements

Achievement 1

Innovation in digital health: the TOURIST studies. I led the conception, development, and analysis of the TOURIST studies, the first digital study of its kind designed to track health in travelers [1-6]. The TOURIST application, which I developed in partnership with the ETH Wearable Computing Lab, combines real-time geographical positioning (GPS), weather, and social media data to geotag health events and study the interactions between health and environment during travel. To assess demographic predictors of health during travel, I used a machine learning technique called classification and regression trees (CART) to successfully identify patterns in traveler type, destination, and health events [3-4]. Using these new methods, I identified “profiles” of traveler types and the patterns of health challenges they faced during their travel. I used a combination of remote sensing data, open source weather data, and daily electronic health surveys to identify spatial and environmental patterns in health events in travelers [2]. I was also asked to collaborate in the development of a highly-cited review of the use of mobile data and mHealth for travel medicine [1]. This year, I supervised a study using the TOURIST data to successfully validate a self-administered new risk triage tool for travelers called the Ready-To-Go Questionnaire [5], also a first of its kind innovation. In recognition of my contributions to the digitalization of travel medicine, I was asked to give the plenary presentation at CISTM16 in 2018 (Washington, DC, USA), and CISTM17 in 2021 (originally Kuala Lumpur, Malaysia, online due to the pandemic). CISTM is the largest conference in travel medicine. I have presented at seven international

and national conferences on the TOURIST studies. I also serve as a consultant on other smartphone application based digital health studies (ITIT, ITITp).

[1] journal-article. S Lai, A Farnham, NW Ruktanonchai, AJ Tatem (2019). Measuring mobility, disease connectivity and individual risk: a review of using mobile phone data and mHealth for travel medicine. Journal of Travel Medicine 26 (3), taz019. DOI.
[2] journal-article. A Farnham, M Röösli, U Blanke, E Stone, C Hatz, MA Puhan (2018). Streaming data from a smartphone application: A new approach to mapping health during travel. Travel Medicine and Infectious Disease 21, 36-42. DOI.
[3] journal-article. A Farnham, R Furrer, U Blanke, E Stone, C Hatz, MA Puhan (2017). The quantified self during travel: mapping health in a prospective cohort of travellers. Journal of Travel Medicine 24 (5), tax050. DOI.
[4] journal-article. A Farnham, V Baroutsou, C Hatz, J Fehr, E Kuenzli, U Blanke, MA Puhan, and S Buehler (2022). Travel behaviours and health outcomes during travel: Profiling destination-specific risks in a prospective mHealth cohort of Swiss travellers. Travel Medicine and Infectious Disease, 47, 102294. DOI.
[5] journal-article. JD Maier, A Anagnostopoulos, A Gazzotti, S Bühler, V Baroutsou, C Hatz, MA Puhan, J Fehr, and A Farnham (2023). The Ready-to-Go Questionnaire predicts health outcomes during travel: a smartphone application-based analysis. Journal of Travel Medicine taad117. DOI.

Achievement 2

New methods using digital data in health research in the Global South. From 2017 to 2023, I served as the coordinator and main analytical supervisor of the HIA4SD project (https://hia4sd.net/), a large research for development (r4d) project employing health impact assessment to understand the impact of resource extraction on population health in Sub-Saharan Africa. In this context, I continued to innovate by incorporating new digital data and data-driven analyses in the global South. I supervised closely a study using machine learning and remote sensing data to classify land use over time in the areas around mines, driving a better understanding of how mining project affect settlement growth and migration [1]. I successfully obtained funding for and started a project (MIGRANT(h)) extending these methods to use satellite and other data to track health and migration in Northern Mozambique after the recent natural disaster (methods publication [2], other publication under review). As part of this project, I manage partnerships with local health institutes, the Ministry of Health, and other local stakeholders. Simultaneously, I became an expert in other data sources available in Sub-Saharan Africa, such as DHS and DHIS2, with an emphasis always on using these data sources to track mobile populations [3-5]. Through this work, I have developed expertise in health impact assessment, a field that utilizes diverse methods (e.g., qualitative focus groups, in-depth interviews, household health surveys, existing health data) to create a holistic, on-the-ground snapshot of the potential population health consequences of a project, policy, or migratory event. Maternal and child health was a special focus of the qualitative research.

[1] journal-article. D Dietler, A Farnham, K de Hoogh, MS Winkler (2020). Quantification of annual settlement growth in rural mining areas using machine learning. Remote Sensing 12 (2), 235. DOI.
[2] journal-article. AV Kulinkina, A Farnham, NK Biritwum, J Utzinger, Y Walz (2023). How do disease control measures impact spatial predictions of schistosomiasis and hookworm? The example of predicting school-based prevalence before and after preventive chemotherapy in Ghana. PLoS Neglected Tropical Diseases. DOI.
[3] journal-article. D Dietler, A Farnham, G Loss, G Fink, MS Winkler (2021). Impact of mining projects on water and sanitation infrastructures and associated child health outcomes: a multi-country analysis of Demographic and Health Surveys (DHS) in sub-Saharan Africa. Globalization and Health 17(1). DOI.

[4] journal-article. A Farnham, MS Winkler, HR Zabre, MJ Divall, G Fink, AM Knoblauch (2022). Spatial mobility and large-scale resource extraction: An analysis of community well-being and health in a copper mining area of Zambia. The Extractive Industries and Society, 9, 101016. DOI.
[5] journal-article. A Farnham, G Loss, I Lyatuu, H Cossa, AV Kulinkina, MS Winkler. A roadmap for using DHIS2 data to track progress in key health indicators in the Global South: experience from sub-saharan Africa. BMC public health 23 (1), 1030. DOI.

Achievement 3

Leadership in mentoring and teaching. I have shown increasing leadership in supervision, mentoring, science communication, and teaching. During the HIA4SD project, I served as the main analytical supervisor of six PhD students and a consultant to several others, resulting in over 25 publications as the analytical lead during my time at Swiss TPH. In addition, I have balanced a heavy load of teaching responsibilities, where I have become known for my ability to translate difficult topics to students. My semester courses include lead lecturer of Introduction to Public Health, Introduction to Biostatistics, co-lead of Statistical Modelling, and co-lead of Effective Presentation Skills.

CV

Mirko Winkler
Current position(s): Group leader, Associate professor or similar
Academic age: 12 year(s) 7 month(s)

Education

Degree	Organisation	Duration
Associate Professor	Universität Basel - BS, CH Medical Faculty	05.2023 - Present 7 month(s)
Habilitation in Epidemiology	Universität Basel - BS, CH Faculty of Natural Sciences	11.2018 - 10.2019 1 year(s)
PhD / Dr.: Epidemiology Prof. Dr. Jürg Utzinger	Schweizerisches Tropen- und Public Health-Institut - Swiss TPH, CH Department of Epidemiology and Public Health	02.2008 - 05.2011 3 year(s) 4 month(s)
Further Advanced Studies: Diploma in Tropical Medicine and Hygiene (DTM&H)	Hospital Nacional Cayetano Heredia, PE Gorgas Memorial Institute of Tropical and Preventive Medicine, Lima, Peru	01.2011 - 03.2011 3 month(s)
Master: Environmental Sciences	ETH Zürich - ETHZ, CH Environmental Sciences	09.2002 - 01.2008 5 year(s) 5 month(s)
Cours des Mathématiques Spéciales (CMS)	EPF Lausanne - EPFL, CH Ecole Polytechnique Fédérale de Lausanne	09.2001 - 07.2002 11 month(s)
Professional Degree in Civil Engineering and Computer Added Design (CAD)	WGG Schnetzer Puskas Ingenieure SIA/ASIC, Basel, Switzerland, CH Civil Engineering and Computer Added Design (CAD)	08.1996 - 06.2000 3 year(s) 11 month(s)

Employment

Role	Organisation	Duration
Associate professor or similar	Universität Basel - BS, CH Medical Faculty/Swiss Tropical and Public Health Institute	05.2023 - Present 7 month(s)
Group leader	Schweizerisches Tropen- und Public Health-Institut - Swiss TPH, CH Department of Epidemiology and Public Health	01.2018 - Present 5 year(s) 11 month(s)
Senior researcher	Schweizerisches Tropen- und Public Health-Institut - Swiss TPH, CH Department of Epidemiology and Public Health	01.2016 - 12.2017 2 year(s)
Lecturer / Reader	Oswaldo Cruz Foundation, BR Escola Nacional de Saúde Púplica Sergio Arouca (ENSP)	04.2015 - 11.2017 2 year(s) 8 month(s)
Junior researcher / Postdoc Prof. Dr. Guéladio Cissé	Schweizerisches Tropen- und Public Health-Institut - Swiss TPH, CH Department of Epidemiology and Public Health	06.2011 - 12.2015 4 year(s) 7 month(s)
Doctoral student / PhD student Prof. Dr. Jürg Utzinger	Schweizerisches Tropen- und Public Health-Institut - Swiss TPH, CH Department of Epidemiology and Public Health	02.2008 - 05.2011 3 year(s) 4 month(s)
Civil Engineering Draftsman and CAD Technologist	WGG Schnetzer Puskas Ingenieure SIA/ASIC, Basel, Switzerland, CH Civil Engineering and Computer Added Design (CAD)	01.2005 - 12.2006 2 year(s)
Field Assistant	Centre Suisse de Recherches Scientifiques en Côte d'Ivoire, CI Santé Urbaine	10.2005 - 02.2006 5 month(s)

Major achievements

Achievement 1

I am the Principal Investigator of the HIA4SD Project (full title: HIA for engaging extraction projects in sustainable development in producer regions), which is funded under the Swiss Programme for Research on Global Issues for Development (r4d programme) of the Swiss National Science Foundation (SNF) (duration: 6 years; budget: CHF 2.7 million; duration: 2017-2023). The HIA4SD Project is a multi- and trans-disciplinary research effort with the overarching aim to inform and facilitate a policy dialogue for strengthening the application of impact assessment as a regulatory mechanism in Africa [1]. Thus far, I have successfully steered this complex project (also during the COVID-19 pandemic) with research partner institutions in Burkina Faso, Ghana, Mozambique, Switzerland and Tanzania. In terms of scientific output, we have published almost thirty papers in the peer-reviewed literature [2]. This was only possible thanks to six PhD students and two brilliant post-docs who carried out a diversity of quantitative [2,3,4], qualitative [5,6] and mixed-methods [7] studies. In addition to scientific outputs, we have translated our research findings into several policy briefs, videos and training courses so that we can reach a broad non-academic audience. In parallel, the HIA4SD Project has pursued comprehensive stakeholder involvement processes nationally (in the project countries) and internationally. In the last project phase, we are currently successfully implementing policy dialogue processes in all four African project countries. The HIA4SD Project will, without any doubt, have a lasting impact – including policy impact – which I consider a major achievement.

[1] journal-article. Farnham, A., Cossa, H., Dietler, D., Engebretsen, R., Leuenberger, A., Lyatuu, I., Nimako, B., Zabre, H. R., Brugger, F., & Winkler, M. S. (2019). Investigating health impacts of natural resource extraction projects in Burkina Faso, Ghana, Mozambique, and Tanzania: a study protocol. JMIR Research Protocols 9: e17138. DOI.
[2] journal-article. Dietler D., Farnham A., Lyatuu I., Fink G., Winkler M.S. (2022) Industrial mining increases HIV risk: Evidence from 39 mine openings across 16 countries in sub-Saharan Africa. AIDS 36: 1573-1581. DOI.
[3] journal-article. Lyatuu I, Winkler MS, Loss G, Farnham A, Dietler D, Fink G (2021) Estimating the mortality burden of large scale mining projects – Evidence from a prospective mortality surveillance study in Tanzania. PLoS Global Public Health 1: e0000008. DOI.
[4] journal-article. Cossa H., Dietler D., Macete E., Munguambe K., Winkler M.S., Fink G. (2022) Assessing the effects of mining projects on child health in sub-Saharan Africa: a multi-country analysis. Globalization and Health 18:7. DOI.
[5] journal-article. Leuenberger A., Cambaco O., Zabré H.R., Lyatuu I., Utzinger J., Munguambe K., Merten S., Winkler M.S. (2021) “It is like we are living in a different world”: health inequity in communities surrounding industrial mining sites in Burkina Faso, Mozambique, and Tanzania. International Journal of Environmental Research and Public Health 18: 11015. DOI.
[6] journal-article. Leuenberger A., Kihwele F., Lyatuu I., Kengiad J.T., Farnham A., Winkler M.S., Merten S. (2020) Health impacts of industrial gold mining on local communities in Tanzania: a gender-focused qualitative study. Impact Assessment and Project Appraisal 39: 183-195. DOI.
[7] journal-article. Leuenberger A., Dietler D., Lyatuu I., Farnham A., Kihwele F., Brugger F., Winkler M.S. (2021) Water infrastructure and health in mining settings: a mixed-methods geospatial visualization. Geospatial Health 16: 965. . DOI.

Achievement 2

In 2019, the Health Section of the International Association of Impact Assessment (IAIA) assigned to me the lead to develop a “Health Impact Assessment (HIA) International Best Practice Principles” paper. As an important first step, we conducted a study to map current global HIA practice [1]. Based

on this study, we produced a first draft of the HIA International Best Practice Principles, which then underwent a rigorous review process with the impact assessment community of IAIA. The new IAIA HIA international best practice principles were published in 2021, with me as the first author [2]. I consider this a particular achievement for two reasons. Firstly, the paper establishes my role as a leading international expert in the field of HIA, which has been my central research topic for more than a decade. Secondly, the paper (published in English, French, Spanish and Portuguese) sets a milestone in our continuous effort to promote HIA practice and research globally, with a particular focus on low- and middle-income countries [3], where disease prevention and health promotion are most needed.

[1] journal-article. Winkler, M. S., Furu, P., Viliani, F., Cave, B., Divall, M., Ramesh, G., Harris-Roxas, B., & Knoblauch, A. M. (2020). Current Global Health Impact Assessment Practice. International Journal of Environmental Research and Public Health, 17(9), 2988. DOI.
[2] online-resource. Winkler, M. S., Viliani, F., Knoblauch, A. M., Cave, B., Divall, M., Ramesh, G., Harris-Roxas, B., & Furu, P. (2021). Health impact assessment international best practice principles. Special Publication Series No. 5. Fargo, USA. International Association for Impact Assessment. Weblink. Open Access.
[3] journal-article. Winkler, M. S., Krieger, G. R., Divall, M. J., Cissé, G., Wielga, M., Singer, B. H., Tannera, M., & Utzingera, J. (2013). Untapped potential of health impact assessment,Un potentiel inexploité de l'évaluation de l'impact sanitaire. Bulletin of the World Health Organization, 91(4), 298–305. DOI. .

Achievement 3

In May 2023, I appointed as Professor of Urban Public Health at the Faculty of Medicine of the University of Basel. The professorship is hosted at the Swiss Tropical and Public Health Institute (Swiss TPH) and is oriented towards innovative, translational and implementation-oriented methodologies that aim to deepen the understanding and promotion of human health and well-being in urban and peri-urban contexts across the globe.

Of the 34 initial applicants, seven candidates made it into the second stage and three into the final stage. Upon completion of the rigorous selection process, the appointment committee ("Berufungskommission") selected me as the "primo loco", which was approved by the"Rektorat" and the "Universitätsrat" of University of Basel in April 2023.

CV

Raushan Bokusheva
Current position(s): Full professor or similar
Academic age: 20 year(s)

Education

Degree	Organisation	Duration
Further Advanced Studies: Venia legendi in Applied Economics	ETH Zürich - ETHZ, CH Environmental Sciences	01.2009 - 02.2012 3 year(s) 2 month(s)
PhD / Dr.: Quantitative Economics Grigory V. Gavrlov	Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, RU Economics	03.1993 - 12.1997 4 year(s) 10 month(s)
Master: Agricultural Economics / Quantitative Economics Grigory V. Gavrilov	Russian State Agrarian University - Moscow Timiryazev Agricultural Academy, RU Economics	08.1987 - 06.1992 4 year(s) 11 month(s)

Employment

Role	Organisation	Duration
Full professor or similar	Zürcher Hochschule f. Angew. Wissenschaften - ZHAW, CH Institute of Natural Resource Sciences	10.2017 - Present 6 year(s) 2 month(s)
Senior Policy Analyst	Organisation For Economic Co-Operation and Development, FR Trade and Agriculture	06.2015 - 07.2017 2 year(s) 2 month(s)

Role	Organisation	Duration
Senior researcher	ETH Zürich - ETHZ, CH Environmental Sciences	12.2007 - 04.2015 7 year(s) 5 month(s)
Senior researcher	Leibniz Institute of Agricultural Development in Transition Economies, DE Structural Development of Farms	09.2001 - 12.2007 6 year(s) 4 month(s)

Major achievements

Achievement 1

Venia Legendi at ETH Zurich (2012). I personally think it was an important milestone in my research carrier. It helped me to develop my own research profile and to delineate my contributions to three large fields of the research in Applied and Agricultural Economics, in particular, (i) Productivity and efficiency analysis, (ii) Decision-making under uncertainty and risk management, and (iii) Microeconomic analysis of businesses' investment decisions. S. below 5 selected papers I published within these research fields.

[1] journal-article. Bokusheva, R. and Barath, L. 2023. State-contingent production technology formulation: Identifying states of nature using reduced-form econometric models of crop yield. American Journal of Agricultural Economics 1–23. . DOI. .
[2] journal-article. Bokusheva, R., Cechura, L. and Kumbhakar, S. 2023. Estimating persistent and transient technical efficiency and their determinants in the presence of heterogeneity and endogeneity. Journal of Agricultural Economics 74: 450–472. . DOI. .
[3] journal-article. Malikov, E., Bokusheva, R. and Kumbhakar, S.C. 2018. A hedonic-output-index-based approach to modeling polluting technologies. Empirical Economics 54: 287–308. . DOI.
[4] journal-article. Bokusheva, R. 2018. Using copulas for rating weather index insurance contracts. Journal of Applied Statistics 45(13) 2328–2356. DOI.
[5] journal-article. Bokusheva, R., Bezlepkina, I. and Oude Lansink, A. 2009. Exploring investment behavior of farms in transition: The case of Russian agriculture. Journal of Agricultural Economics 60(2): 436–464. DOI.

Achievement 2

OECD Senior Policy Analyst, invited position (2015-2017): Performing and coordinating policy-relevant research and communicating it to policy-makers. The assignement at the OECD was a great opportunity to contribute to the OECD work of monitoring and evaluating national policies as well as developing normative policy frameworks at the international level.

In addition, experiences collected during this time do still strongly motivate me to conduct applied economic research of high policy relevance.

[1] report. Cross-Country Comparison of Farm Size Distribution. (2016). Organisation for Economic Co-Operation. https://doi.org/10.1787/5jlv81sclr35-en. DOI.
[2] report. Evaluating dynamics, sources and drivers of productivity growth at the farm level. (2017). Organisation for Economic Co-Operation. https://doi.org/10.1787/5f2d0601-en. DOI.

Achievement 3

Establishing a research group in Agricultural and Resource Economics performing high-quality applied research in areas such as Economics of climate change, Environmental valuation, and Productivity and sustainability in food value chains.

This activity has required the acquisition of several larger third-party funded projects, establishing a network of partner institutions and boosting the international and national visibility of the group.

Currently my group implements two large research projects investigating the impact of climate change on land use, agricultural productivity and policy options for inducing farmers to engage in climate mitigation activities. Within an ERANet-RUS + project, jointly with project partners from KU Leuven and Leibniz Institute for Africultural Development in Transition Economies (IAMO), we examine agriculture potential in Kazakhstan, Ukraine and Russia to meet triple challenge: increase food production, foster rural development, and mitigate and adapt to climate change. Within a Horizon Europe project, my team is a part of a large research consortium that investimates how the European land use sector can archive climate neutrality by 2035.

[1] website. LAMASUS – Land Management for Sustainability. A research project funded by the European Union's Horizon Europe Research and Innovation programme. . Open Access.
[2] conference-paper. Kunze, Sven; Bokusheva, Raushan; Laiko, Olga, 2023. What drives agricultural land use change in Eurasia? In: XVII European Association of Agricultural Economists Congress (EAAE), Rennes, France, 29 August - 1 September 2023.
[3] conference-paper. Bokusheva, Raushan; Bozzola, Martina; Kunze, Sven, 2022. Modelling the impact of climate change on agriculture productivity in Russia. In: 96th Annual Conference of the Agricultural Economics Society, Leuven, 4-6 April 2022.

CV

Eusebio Macete
Current position(s): Head of (e.g. institute, department, center, clinic), Senior Associated Researcher (former director)
Academic age: 24 year(s) 4 month(s)

Education

Degree	Organisation	Duration
Further Advanced Studies: Public Health Specialist	Ministry of Health, MZ Infectious Disease	10.2009 - 09.2010 1 year(s)
PhD / Dr.: Health Sciences	University of Barcelona, ES Health Sciences	01.2005 - 01.2008 3 year(s) 1 month(s)
Master: Masters in Public Health	Pompeu Fabra University, ES Public Health	09.2003 - 06.2005 1 year(s) 10 month(s)
Bachelor: Medicine	Eduardo Mondlane University, MZ Medicine	09.1994 - 06.1999 4 year(s) 10 month(s)

Employment

Role	Organisation	Duration
Head of (e.g. institute, department, center, clinic)	Farmacias de Moçambique, MZ Farmac SA	06.2021 - Present 2 year(s) 6 month(s)
Senior Associated Researcher (former director)	Manhiça Health Research Centre, MZ Manhiça Health Research Center	06.2021 - Present 2 year(s) 6 month(s)

17 November 2023, Eusebio Macete, ORCID iD 0000-0002-8071-4761

Role	Organisation	Duration
Head of (e.g. institute, department, center, clinic)	Manhiça Health Research Centre, MZ Manhiça Health Research Center	01.2008 - 05.2021 13 year(s) 5 month(s)
Group leader	Manhiça Health Research Centre, MZ Manhiça Health Research Center	01.2002 - 12.2007 6 year(s)
Research associate / Scientific collaborator	Ministry of Health, MZ Department of Epidemiology	01.1996 - 05.1999 3 year(s) 5 month(s)

Major achievements

Achievement 1

International leadership in health research: Since 2002, he has participated in the design, implementation and analysis of several clinical trials, including the evaluation of intermittent preventive treatment of malaria in children and the evaluation of the RTS,S malaria vaccine in Mozambique. In 2008/09, he was Chairman of the CTPC Clinical Trials Partnership Committee in the context of the clinical trials of the same vaccine. In 2011, he was a member of the Installing Committee of the Initiative to Strengthen Health Research Capacity in Africa (ISHReCA). Between 2011 and 2014, he was vice-president of the INDEPTH network (multiregional network of research centers with population follow-up on a demographic platform). Since 2015, he has been a member of the advisory board of the Institute of Hygiene and Tropical Medicine of Lisbon in Portugal. He represents Mozambique at the EDCTP General Assembly (the European and Developing Countries Clinical Trials Partnership EDCTP is a public-public partnership between countries in Europe and sub-Saharan Africa, supported by the European Union), and was vice-president of the EDCTP Association until 2019. He is the coordinator of the TESA-II network (network of centers of excellence in Southern Africa) and is the President of the National Polio Eradication Commission in Mozambique. He is currently a member of the Advisory Group of the World Health Organization's Programme for Steering the Implementation of Malaria Vaccines (RTS,S) by, WHO_PMM (WHO_GMP). He was recently appointed to the COVID-19 vaccine working group as a support group to the SAGE Strategic Support Group of WHO Geneva.

Achievement 2

A decade of leadership at CISM: For over a decade, he was the leader of CISM, a centre of excellence in biomedical research in Africa and leader in the study of malaria and other infectious diseases. CISM has been responsible for many landmark scientific achievements, including the clinical development of the malaria vaccine (RTS,S), the generation of data that facilitate the implementation of pneumonia and diarrhoea vaccine programmes in Mozambique, and the development of novel strategies for malaria prevention during pregnancy that have been incorporated into World Health Organisation recommendations. Other pioneering projects at CISM include surveillance systems designed to facilitate research. These include demographic, microbiological and disease surveillance platforms operated by Manhiça District Hospital, which generate data and scientific evidence that is used to inform health policy decisions taken by the Mozambican government.

Achievement 3

Prolific scientific publication: In over two decades of scientific work, he has been part of more than 50 scientific publications, the most prominent first and last author papers are listed here.

[1] journal-article. Macete E , Sacarlal J, Aponte JJ, Leach A, Navia MM, Milman J, Guinovart C, Mandomando I, López-Púa Y, Lievens M, Owusu-Ofori A, Dubois MC, Cahill CP, Koutsoukos M, Sillman M, Thompson R, Dubovsky F, Ballou WR, Cohen J, Alonso PL. Trials. Evaluation of two formulations of adjuvanted RTS, S malaria vaccine in children aged 3 to 5 years living in a malaria-endemic region of Mozambique: a Phase I/IIb randomized double-blind bridging trial.2007 Mar 26;8:11. DOI.
[2] journal-article. Macete E, Aponte JJ, Guinovart C, Sacarlal J, Ofori-Anyinam O, Mandomando I, Espasa M, Bevilacqua C, Leach A, Dubois MC, Heppner DG, Tello L, Milman J, Cohen J, Dubovsky F, Tornieporth N, Thompson R, Alonso PL. Trop Med Int Health. Safety and immunogenicity of the RTS,S/AS02A candidate malaria vaccine in children aged 1-4 in Mozambique. 2007 Jan;12(1):37-46. DOI.
[3] journal-article. Macete E, Aide P, Aponte JJ, Sanz S, Mandomando I, Espasa M, Sigauque B, Dobaño C, Mabunda S, DgeDge M, Alonso P, Menendez C. J Infect Dis. Intermittent preventive treatment for malaria control administered at the time of routine vaccinations in Mozambican infants: a randomized, placebo-controlled trial. 2006 Aug 1;194(3):276-85. Epub 2006 Jun 30. . DOI.
[4] journal-article. Rupérez M, González R, Mombo-Ngoma G, Kabanywanyi AM, Sevene E, Ouédraogo S, Kakolwa MA, Vala A, Accrombessi M, Briand V, Aponte JJ, Manego Zoleko R, Adegnika AA, Cot M, Kremsner PG, Massougbodji A, Abdulla S, Ramharter M, Macete E, Menéndez C. Mortality, Morbidity, and Developmental Outcomes in Infants Born to Women Who Received Either Mefloquine or Sulfadoxine-Pyrimethamine as Intermittent Preventive Treatment of Malaria in Pregnancy: A Cohort Study. PLoS Med. 2016 Feb 23;13(2):e1001964. DOI.
[5] journal-article. Nhama A, Bassat Q, Enosse S, Nhacolo A, Mutemba R, Carvalho E, Naueia E, Sevene E, Guinovart C, Warsame M, Sanz S, Mussa A, Matsinhe G, Alonso P, Tiago A, Macete E. In vivo efficacy of artemether-lumefantrine and artesunate-amodiaquine for the treatment of uncomplicated falciparum malaria in children: a multisite, open-label, two-cohort, clinical trial in Mozambique. Malar J. 2014 Aug 10;13:309. DOI.

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