climatechangecounts

STRENGTHENING UNIVERSITY CONTRIBUTIONS TO CLIMATE COMPATIBLE DEVELOPMENT IN SOUTHERN AFRICA

Tanzania Country Report

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SARUA CLIMATE CHANGE COUNTS MAPPING STUDY

VOLUME 2 COUNTRY REPORT 10 2014

STRENGTHENING UNIVERSITY CONTRIBUTIONS TO CLIMATE COMPATIBLE DEVELOPMENT IN SOUTHERN AFRICA

Tanzania Country Report

Series Editor: Piyushi Kotecha

Authors: Penny Urquhart and Heila Lotz-Sisitka

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Note

This is the Tanzania Country Report of the Southern African Regional Universities Association (SARUA) ***Climate Change Counts*** *mapping study. It brings together background documentation on climate change in Tanzania, insights into knowledge and research needs and capacity gaps (individual and institutional), a mapping of existing university roles and contributions to climate compatible development (CCD); as well as a discussion on possibilities for CCD learning pathways and future collaborative knowledge co-production and use in Tanzania.*

This report is one of a set of 12 Country Reports in Volume 2, which inform Volume 1: the integrated regional Knowledge Co-production Framework of the ***Climate Change Counts*** *mapping study, and which includes comparative regional analysis using the outputs of the other SADC countries, as well as the proposed regional framework for collaborative research on climate compatible development.*

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SARUA is a not-for-profit leadership association of the heads of the public universities in the 15 countries of the SADC region. Its mission is to promote, strengthen and increase higher education, research and innovation through expanded inter-institutional collaboration and capacity-building initiatives throughout the region. It promotes universities as major contributors towards building knowledge economies, national and regional socio-economic and cultural development, and for the eradication of poverty.

*The **Climate Change Counts** mapping study is the inception phase of the SARUA Programme for Climate Change Capacity Development. The mapping study was made possible through the professional, financial and in-kind support of multiple partners. The principal study sponsor was the Climate and Development Knowledge Network (CDKN).*

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Contents

Tables

Figures

Acronyms

BID	Background Information Document
CBO	Community Based Organisation
CCAM	Conformal-Cubic Atmospheric Model
CCD	Climate compatible development
CCIAM	Climate Change Impacts Adaptation and Mitigation
CDKN	Climate and Development Knowledge Network
CDM	Clean Development Mechanism
CDM	Clean Development Mechanism
CGCMs	Coupled Global Climate Models
COSTECH	Commission for Science and Technology
CSIR	Council for Scientific and Industrial Research
DUCE	University of Dar es Salaam College of Education
ESDP	Education Sector Development Programme
ESRF	Economic and Social Research Foundation
FFEWS	Famine and Flood Early Warning System
GHG	GreenHouse Gas
HEDP	Higher Education Development Programme
HEI	Higher Education Institution
HEMA	Higher Education Management Africa consortium
ICT	Information and Communication Technology
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
IRA	Institute of Resource Assessment
LEAT	Lawyers Environmental Action Team
LKCCAP	Local Knowledge Climate Change Adaptation Programme
MUCE	Mkwawa University College of Education
MUHAS	Muhimbili University of Health & Allied Sciences
NAMA	Nationally Appropriate Mitigation Action
NAP	National Action Plan
NAPA	National Adaptation Programme of Action
NCCFP	National Climate Change Focal Point
NCCS	National Climate Change Strategy
NCCSC	National Climate Change Steering Committee
NCCTC	National Climate Change Technical Committee
NCSA	National Capacity Self-Assessment
NGO	Non-Governmental Organisation
OSSREA	Organisation for Social Science and Research in East Africa
OUT	Open University of Tanzania

PMORALG	Prime Minister's Office Regional Administration and Local Government
R&D	Research and Development
REDD	Reduced Emissions from Deforestation's and Forest Degradation
REPOA	Research for Poverty Alleviation
SADC	Southern African Development Community
SADC REEP	Southern African Development Community Regional Environmental Education Programme
SARUA	Southern African Regional Universities Association
SASSCAL	Southern African Science Service Centre for Climate Change and Adaptive Land Use
SCCF	Special Climate Change Fund
SET	Science, Engineering and Technology
SNC	Second National Communication
SUA	Sokoine University of Agriculture
SWAAT	Society for Women and Aids in Africa -Tanzania
TaCRI	Tanzania Coffee Research Institute
TAFIRI	Tanzania Fisheries Research Institute
TAFORI	Tanzania Forestry Research Institute
TaTEDO	Tanzania Technology Development Organisation
TAWIRI	Tanzania Wildlife Research Institute
TGNP	Tanzania Gender Network Programme
TMA	Tanzania Meteorological Agency
TRIT	Tea Research Institute of Tanzania
TROCEN	Tropical Research Centre for Oceanography, Environmental and Natural Resources
UDSM	University of Dar es Salaam
UNDP	United Nations Development Programme
UNFCCC	UN Framework Convention on Climate Change
VPO-DOE	Vice President's Office, Department of Environment
ZCCA	Zanzibar Climatic Change Alliance

1 INTRODUCTION

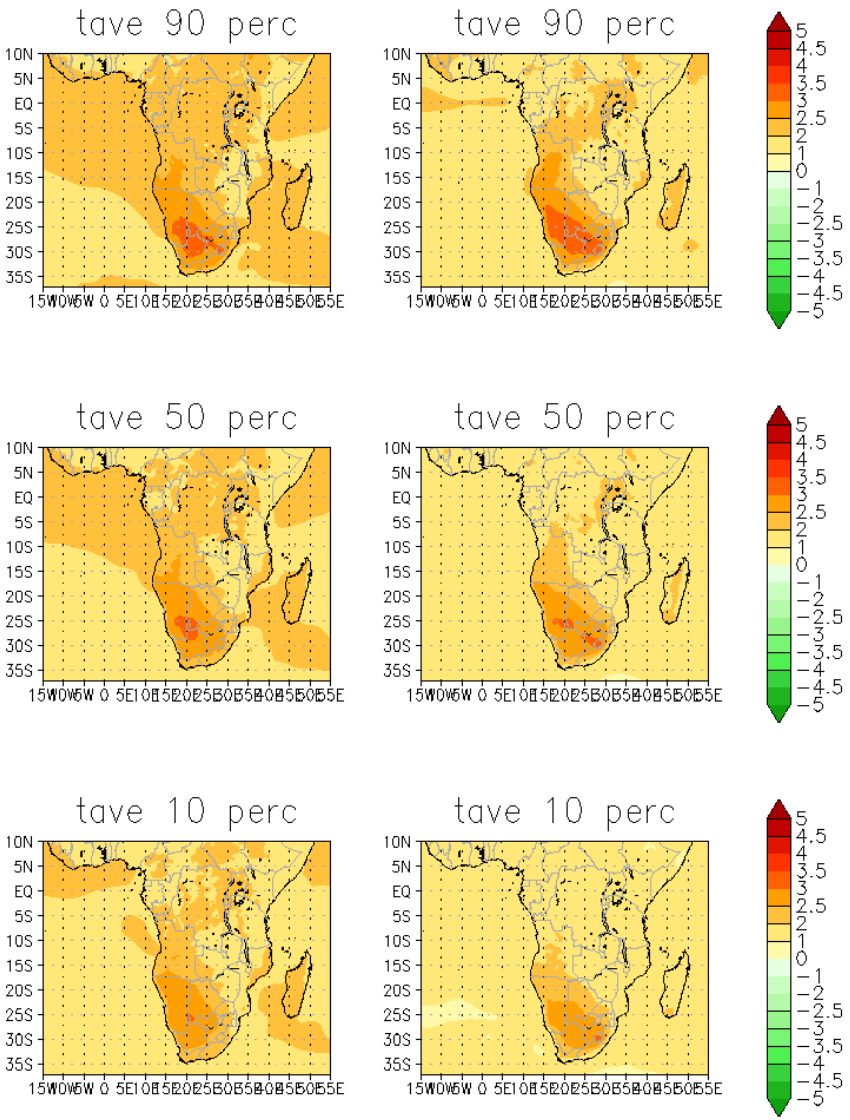
1.1 Regional climate risks and university leadership for climate compatible development in southern Africa

Globally, southern Africa is one of the most vulnerable regions to the impacts of climate change. Current climate variability and vulnerability to extreme events such as floods and droughts is high, and a range of existing stressors, including water availability, land degradation, desertification and loss of biodiversity constrain food security and development. Reduction of the region's structural poverty is further challenged by health threats such as malaria and HIV/AIDS, as well as institutional and governance aspects. Climate change will compound many of these interlinked problems for regional livelihoods, which are often based on subsistence agriculture, and for regional economies, which are often dependent on natural resources. The region's high vulnerability to climate change is a function of the severity of the projected physical climate impacts and this multi-stressor context, which heightens both exposure and sensitivity to the impacts.

In addition to its role as a risk multiplier, climate change introduces new climate risks. Already the observed temperature changes for southern Africa are higher than the increases reported for other parts of the world (IPCC 2007); projections indicate a 3.4°C increase in annual temperature (up to 3.7°C in spring), when comparing the period 1980–1999 with the period 2080–2099. Mean warming over land surfaces in Southern Africa is likely to exceed the average global land surface temperature increases in all seasons.[1] Further projections are for overall drying for southern Africa, with increased rainfall variability; a delay in onset of the rainy season with an early cessation in many parts; and an increase in rainfall intensity in some parts. [See Figure 1.[2]] Additional climate-driven risks, in addition to the direct effects of increased temperature and increased incidence and/or severity of extreme events like floods and droughts, include more wind storms, hot spells and wild fires. Both the heightened and the new risks will act at the local level to compound other stressors and development pressures faced by people, and at the national level on the region's natural resource-dependent economies. The all-encompassing nature of the impacts highlights the fact that climate change is not a narrow environmental problem, but a fundamental development challenge that requires new and broad-based responses.

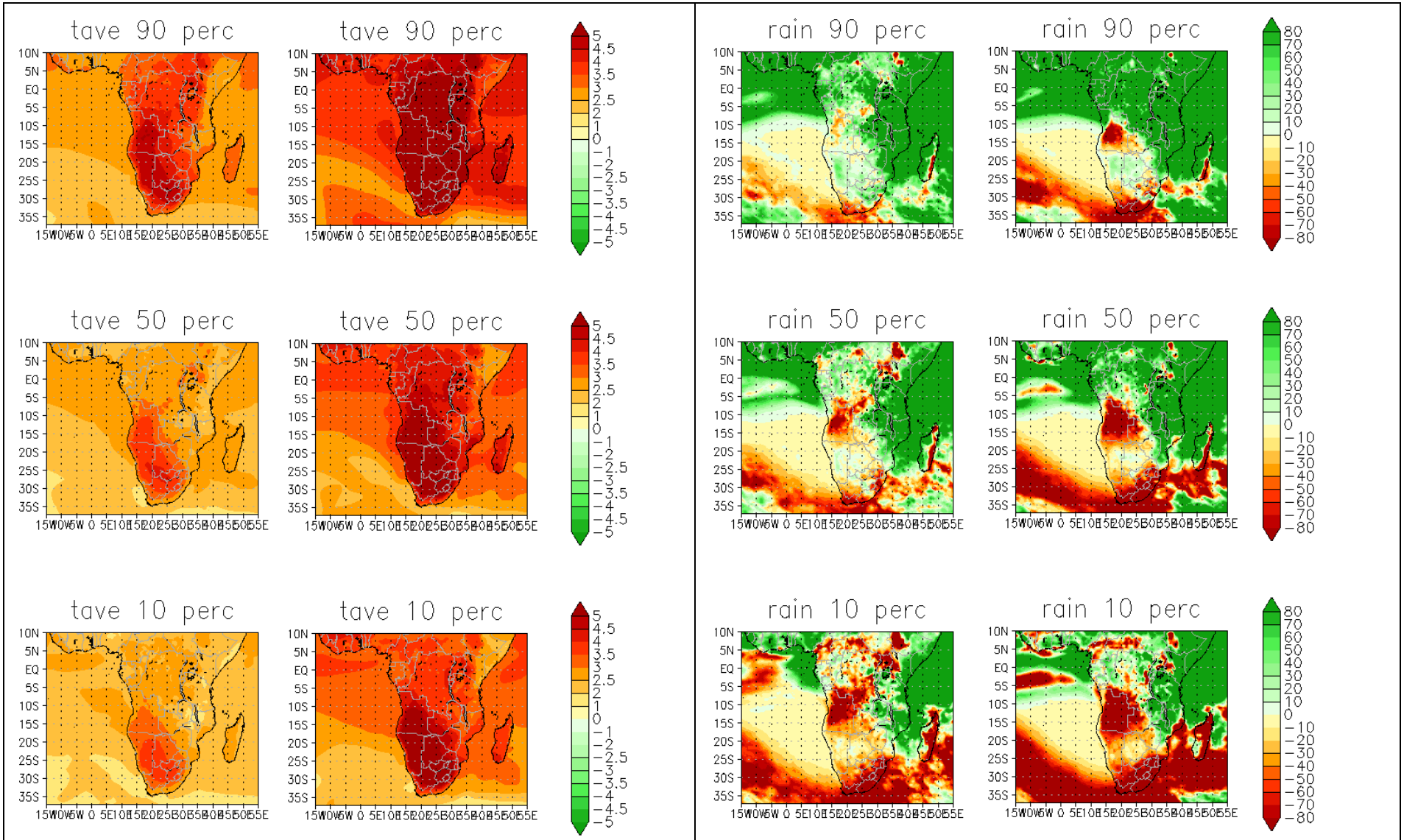
[1] IPCC. 2013. *Impacts, Vulnerability and Adaptation: Africa*. IPCC Fifth Assessment Report, draft for Final Government Review, Chapter 22.

[2] The projections of future climate change displayed in Figures 1 and 2 were provided by the Council for Scientific and Industrial Research (CSIR), and have been obtained through downscaling the output of a number of coupled global models (CGCMs) to high-resolution over Africa, using a regional climate model. All the CGCMs downscaled contributed to the Coupled Model Intercomparison Project Phase 5 (CMIP5) and Assessment Report 5 (AR5) of the Intergovernmental Panel on Climate Change (IPCC). Details on these simulations are provided in the LTAS Phase 1 Technical Report no. 1. The regional model used is the conformal-cubic atmospheric model (CCAM), developed by the CSIRO in Australia. For various applications of CCAM over southern Africa, see Engelbrecht, F.A., W.A. Landman, C.J. Engelbrecht, S. Landman, B. Roux, M.M. Bopape, J.L. McGregor and M. Thatcher. 2011. "Multi-scale climate modelling over southern Africa using a variable-resolution global model," *Water SA* 37: 647-658.



Note: The 90th percentile (upper panel), median (middle panel) and 10th percentile (lower panel) are shown for an ensemble of downscalings of three CGCM projections, for each of the time-slabs. The downscalings were performed using the regional model CCAM. All the CGCM projections are contributing to CMIP5 and AR5 of the IPCC, and are for RCP4.5.

Figure 1: Projected change in the annual average temperature (°C) and annual average rainfall (mm) over the SADC region, for the time-slab 2040–2060 and 2080–2099, relative to 1970–2005



Note: The 90th percentile (upper panel), median (middle panel) and 10th percentile (lower panel) are shown for an ensemble of downscalings of three CGCM projections, for each of the time-slabs. The downscalings were performed using the regional model CCAM. All the CGCM projections are contributing to CMIP5 and AR5 of the IPCC, and are for RCP8.5.

Figure 2: Projected change in the annual average temperature (°C) and annual average rainfall (mm) over the SADC region, for the time-slab 2040–2060 and 2080–2099, relative to 1970–2005

Figures 1 and 2[3] showed the projected change in the annual average temperature (°C) and annual average rainfall (mm) over the SADC region, for the time-slabs 2040–2060 and 2080–2099, relative to 1970–2005. Figure 1 CGCM projections are for RCP4.5 and Figure 2 projections are for RCP8.5.

Shifting perspective from 'development' to 'climate compatible development' requires significant scientific and social innovation. New forms of learning, leadership, planning, policy making and knowledge production are needed. New collaboration platforms will be needed within and between countries and their universities. Universities have a key role to play in supporting societal innovation and change for CCD. Not only do they develop the knowledge and competence of future leaders in government, business and civil society, but they also provide immediate societal responses given their pivotal role as centres of research, teaching, knowledge sharing and social empowerment. Given the risk multiplier effect of climate change, coupled with the multiple stressor context, it is clear that the impacts of climate change will be far-ranging, acting upon diverse sectors such as transportation, agriculture, health, industry and tourism. This necessitates a wide-ranging and cross-sector response, in which non-climate-related knowledge fields will be called upon.

Universities need to develop a strong understanding of the knowledge, teaching, research and outreach implications of the external climate change development context in which they operate. This calls for:

- New scientific directions and practices;
- New teaching and learning content and approaches ;
- Stronger forms of community outreach and policy outreach activities; and
- Enhanced collaboration between universities and other knowledge producers and users in society.

In recognition of the above issues and their longer-term implications for society and universities, the Southern African Regional Universities Association (SARUA) hosted a Leadership Dialogue in 2011, which resulted in a vision for a collaborative programme on climate change capacity development, with a defined set of outcomes. This programme is highly relevant for Tanzania, given the country's vulnerability to the impacts of climate change (Box 1).

[3] Engelbrecht et al. 2014. "Multi-scale climate modelling". Climate trends and scenarios for South Africa. Long-term Adaptation Scenarios Flagship Research Programme (LTAS). Phase 1, Technical Report no. 1.

Box 1: Tanzania's vulnerability to climate change

Tanzania's population depends highly on natural resources for their livelihoods leaving Tanzanians with high levels of vulnerability to the impacts climate change, which is compounded by poverty, population density, and environmental degradation. According to the INC, vulnerable sectors include agriculture, water resources, forestry, grasslands, livestock, coastal resources and wildlife and biodiversity. The particular vulnerability of coastal zones threatens natural ecosystems, infrastructure and agriculture. The runoff of three major rivers will be altered. In areas where rainfall will increase, the leaching of nutrients, washing away of the topsoil and water logging will affect plant development and yield. Climate change would favour the occurrence of disease and pests, due to the higher temperatures and increased rainfall. Mount Kilimanjaro's glacier has been reduced by 80 percent since 1912 and it is projected that the entire glacier will be lost by 2025. Further observed impacts include the intrusion of sea water into water wells. Warming temperatures are projected to cause more frequent and more intense extreme weather events, such as heavy rainstorms, flooding, fires, tropical storms and El Niño events. More information of Tanzania's vulnerability to climate change is addressed in section 3.3.3 of this report.

1.2 The SARUA Climate Change initiative: History and objectives

Arising from the 2011 Leadership Dialogue, SARUA designed a five-year programme for Climate Change Capacity Development, to deliver on its mandate of promoting, strengthening and increasing higher education research and innovation, through expanded inter-institutional collaboration and capacity building initiatives throughout the region. The five-year programme is endorsed by a majority of Vice Chancellors within SARUA's 62 public university members (as at August 2013). The programme aims to build capacity for climate compatible development (CCD), which is emerging as a platform for significant collaboration across the academic sector. The objectives identified are as follows:

- **Collaborative network development** (establishment of six interesting collaborative networks);
- **Policy and community outreach;**
- **Research** (140 PhD students (average 10 per country) in two themed research programmes);
- **Teaching and learning** (integration of CCD into undergraduate and Masters degree programmes);
- **Knowledge management** (regional database and knowledge management systems);
- **Institutional learning and support** (ongoing reflexive development of programme).[4]

[4] Butler-Adam, J. 2012. The Southern African Regional Universities Association (SARUA). Seven Years of Regional Higher Education Advancement. 2006-2012. Johannesburg: SARUA.

The programme started with an extensive **mapping study** of current climate-related priorities and university capabilities for CCD of countries in the region, supported by funding from the UK and Dutch-funded Climate and Development Knowledge Network (CDKN). The Higher Education Management Africa consortium (HEMA) is coordinating the study on behalf of SARUA. This Tanzania Country Report forms part of the mapping study.

The initiative is diagrammatically illustrated below.

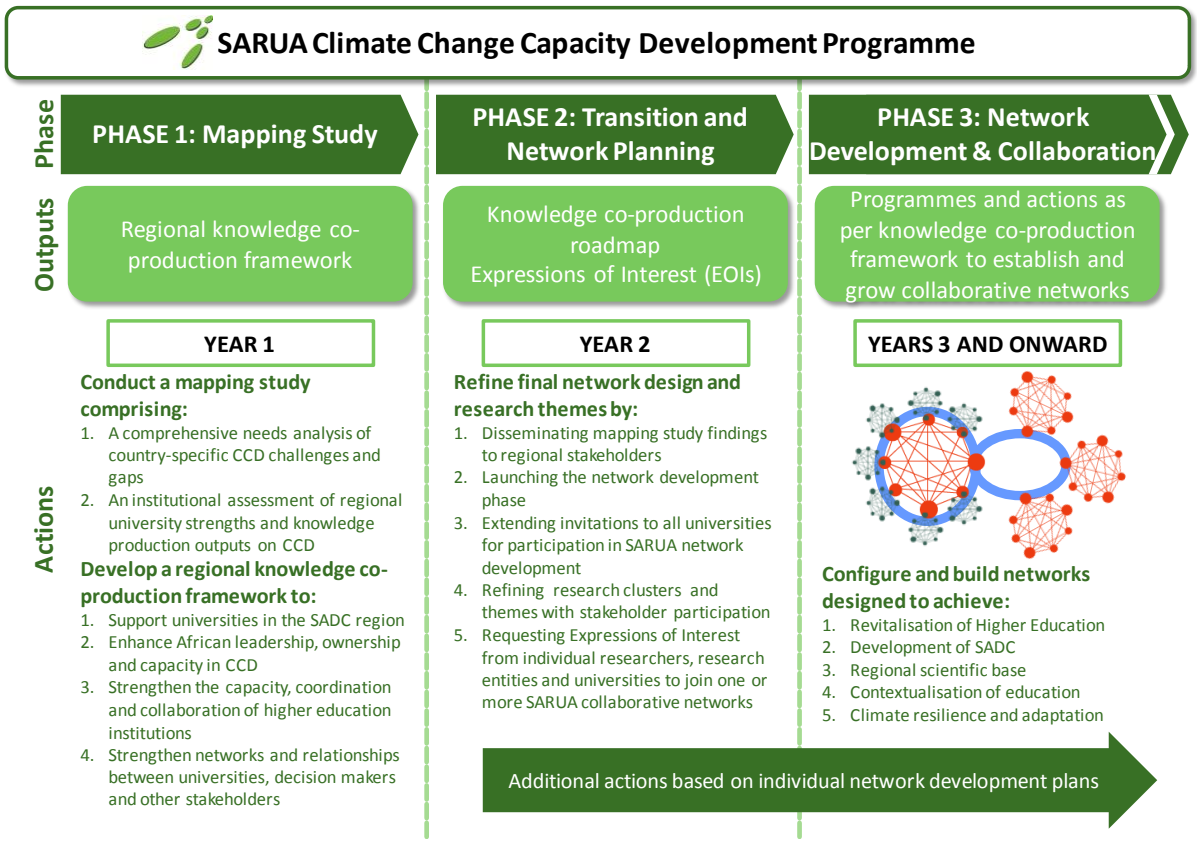


Figure 3: The SARUA Climate Change Capacity Development Programme, showing the mapping study

The intended outcome of the SARUA **mapping study** will be a collaborative research framework to enhance co-production of knowledge on CCD. It will include strategies to strengthen networks for climate compatible development research, teaching, community and policy outreach involving knowledge co-production processes between participating universities and policy and community stakeholders. This framework will form the basis for the realisation of the longer term objectives of the SARUA programme outlined above, as well as for a SADC-level research programme and various country-based partnership agreements. It will provide a 'knowledge platform' for regional and country-based fundraising for research and knowledge co-production. As such the framework seeks to benefit universities themselves, while also strengthening regional interaction and co-operation.

The Regional Knowledge co-production Framework for Climate Compatible Development can be obtained from the SARUA website www.sarua.org.

1.3 The SARUA CCD mapping study: Mapping existing capacity and future possible knowledge co-production possibilities

Climate compatible development (CCD) is low carbon, climate resilient development. While the concept clearly requires integration of development, adaptation and mitigation (see definitions below), specific framing of the concept of CCD may vary between countries, universities and disciplines, according to differing national, institutional and disciplinary goals, needs and values. The scope and strength of existing expertise, networks and capacity for climate compatible development research and knowledge production in SADC is largely unknown or unconsolidated. Despite the emerging knowledge infrastructure for CCD in the region, opportunities for collaboration involving higher education institutions within and between countries are yet to be fully explored.

To address these factors, the mapping study aimed to:

- Explore diverse understandings of CCD on a country-by-country basis;
- Scope CCD knowledge and capacity needs on a country-by-country basis (a 'needs analysis');
- Identify and map research, teaching and outreach capabilities for CCD that exist in southern African countries (an 'institutional analysis' of SARUA member universities); and
- Produce an up-to-date picture of the extent of knowledge co-production and trans-disciplinary research practices across the SARUA network and identify opportunities for future collaboration.

While the mapping process has used a country-by-country approach, this is supplemented by a regional perspective generated through analysis across countries, to provide a platform for regional collaboration and knowledge co-production. This document contains the country analysis from Tanzania.

The mapping process was designed to be scientifically informed, participatory and multi-disciplinary. Through the workshop process new collaborative possibilities will emerge, and a stronger engagement and participation in the SARUA five-year programme on Capacity Development for Climate Change will be established.

1.4 Key concepts

Climate Compatible Development

Climate compatible development (CCD) is low carbon, climate resilient development. The concept has been developed in recognition of the urgent need for adaptation, given current climate variability and the severity of projected climate impacts that will affect the region; and the need to reduce emissions as rapidly as possible to avoid more catastrophic climate change in the future. Thus while CCD can be framed in different ways, given nationally and locally specific development trajectories, it does require that current and future climate risks are mainstreamed into development, and that both adaptation and mitigation are integral goals of development, as indicated by Figure 3. Thus CCD not only recognises the importance of both adaptation and mitigation in new development pathways, but, as further explained in Mitchell and Maxwell (2010), "Climate compatible development goes one step further by asking policy makers to consider 'triple

win' strategies that result in low emissions, build resilience and promote development simultaneously". In the southern African context, poverty reduction, as an integral component and goal of regional and national development strategies, would be a desired co-benefit. Uncertainties in major drivers of change, including climate, socio-economic and political risks, necessitate that CCD be viewed as an iterative process, in which vulnerability identification and risk reduction responses are revised on the basis of continuing learning. Climate compatible development emphasises climate strategies that embrace development goals and development strategies that integrate the threats and opportunities of a changing climate.[5] Thus climate compatible development opens up new opportunities for interdisciplinary and transdisciplinary research, teaching and engagement with communities, policy makers and practitioners.

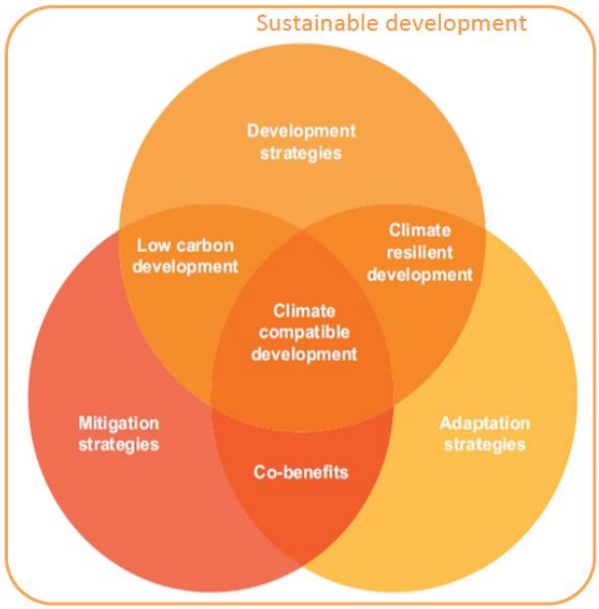


Figure 4: Conceptual framework for Climate Compatible Development (adapted from Mitchell and Maxwell, 2010)

While CCD is the central concept used in the work that is funded by CDKN, it is important that this is understood alongside the concept of climate-resilient development pathways as defined by the Intergovernmental Panel on Climate Change (IPCC) and the wider concept of sustainable development (see definitions below).

[5] Mitchell, T. and S. Maxwell. 2010. *Defining climate compatible development.* CDKN Policy Brief, November 2010.

Climate-resilient pathways

The following definition of climate-resilient pathways is taken from the glossary of the Fifth Assessment Report prepared by the Intergovernmental Panel on Climate Change (IPCC)[6]:

> *"Evolutionary processes for managing change within complex systems in order to reduce disruptions and enhance opportunities. They are rooted in iterative processes of identifying vulnerabilities to climate change impacts; taking appropriate steps to reduce vulnerabilities in the context of development needs and resources and to increase the options available for vulnerability reduction and coping with unexpected threats; monitoring emerging climate parameters and their implications, along with monitoring the effectiveness of vulnerability reduction efforts; and revising risk reduction responses on the basis of continuing learning. This process may involve a combination of incremental changes and, as necessary, significant transformations."*

The IPCC highlights the need for a focus on both adaptation and mitigation, as indicated by the following sentence: "Climate-resilient pathways are development trajectories that combine adaptation and mitigation to realise the goal of sustainable development. They can be seen as iterative, continually evolving processes for managing change within complex systems."[7]

Sustainable Development

The most widely accepted definition of sustainable development, as formulated in the Bruntland Commission's 'Our Common Future' report in 1987, is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". This definition has been highly influential in shaping international environmental and development policy, since the Rio Earth Summit in 1992, where Agenda 21 was put forward as a global development plan for aligning goals of economic development with social and environmental sustainability. Early discussions on sustainable development tended to focus on the triple bottom line concepts of environment, economy and society separately. More recent discussions on sustainable development foreground the need for 'strong sustainability', in which society, economy and environment are seen as interacting in an interrelated, nested system. The concept of sustainable development as used widely today emphasises that everything in the world is connected through space, time and quality of life, and thus necessitates a systems approach to understanding and solving interlinked social, environmental and economic problems.

In 2002 South Africa hosted the World Summit on Sustainable Development, and the Johannesburg Plan of Implementation re-affirmed commitment to Agenda 21, and the Millennium Development Goals. These are currently under review and will be expanded through Sustainable Development Goals. In 2012 the Rio+20 Conference was held in Rio de Janeiro, and the outcomes of this global summit on sustainable development are captured in a document entitled 'The Future We

[6] IPCC. 2013. *Fifth Assessment Report: Impacts, Vulnerability and Adaptation*. Currently in draft form.

[7] Ibid.

Want'. One major shift in discourse and objectives from the early 1992 Summit and the Rio+20 Summit is a stronger concern for climate change and climate compatible development, especially the emergence of a low carbon future, accompanied and partly implemented by Green Economies. These international commitments, together with ongoing assessment of national sustainable development concerns and goals, have driven the development of sustainable development policy and practice. The concept of CCD highlights the necessity of integrating current and future climate risks into development planning and practice, in the ongoing goal of achieving sustainable development.

2 METHODOLOGY, DATA SOURCES AND ANALYSIS LOGIC

2.1 Research design

This country-based study has been informed by an interactive and dialogical research design that included document analysis of key national and regional documents focusing on climate change in Tanzania and in the SADC region. This produced an initial analysis which was used to plan for and engage university participants and national organisations involved in the climate change and development arenas in a consultation to discuss a) the validity of the analysis, and b) expanded views and perspectives on the analysis, and to generate further insight into knowledge co-production practice and possibilities for climate compatible development.

The following methods were used to compile the mapping study Country Report for Tanzania, within an overall interpretive, participatory and consultative and social realist methodology[8]:

2.1.1 Document analysis

The country Background Information Document (BID) provides a summary of needs, priorities and capacity gaps already identified within key country documents (see below) for climate change, adaptation and mitigation, and in some cases, where this was available, climate compatible development. This was used as a source of background information for the stakeholder and institutional consultations held in each country. While the scope of CCD is necessarily wide, the document analysis did not focus on sectoral policy and institutions, but concentrated on overarching policy dealing with mainstreaming climate change into planning and development. The initial document analysis was presented to stakeholders during the workshops, and was revised based on outcomes of the consultations held in the country. In addition to drawing on the BID, the following documents were analysed through rapid desk review, to develop the Tanzania Country Report:

- Initial National Communication (INC) to the United Nations Framework Convention on Climate Change (UNFCCC), 2003;
- National Adaptation Programme of Action (NAPA), 2007;
- National Capacity Self-Assessment (NCSA) for implementation of the Rio Conventions, 2007;
- UNDP Climate Change Country Profile for Tanzania, 2012[9];
- Tanzania National Climate Change Strategy, 2012; and
- 'Using climate information to support adaptation planning and policy-making: A practical case study in Bagamoyo District, coastal Tanzania', Stockholm Environment Institute and Climate System Analysis Group (Besa 2013).

[8] A social realist methodology takes account of knowledge that has previously been established via scientific methods before engaging with consultative and participatory knowledge production processes.

[9] McSweeney, C., M. New and G.Lizcano, 2012. "UNDP Climate Change Country Profiles: Tanzania". Available at http://www.geog.ox.ac.uk/research/climate/projects/undp-cp/index.html?country=Tanzania&d1=Reports, accessed 17 September 2013. McSweeney, C., M. New, G. Lizcano and X. Lu. 2010. "The UNDP Climate Change Country Profiles Improving the Accessibility of Observed and Projected Climate Information for Studies of Climate Change in Developing Countries," *Bulletin of the American Meteorological Society* 91, 157-166.

2.1.2 Stakeholder and university staff consultations (national workshop)

As part of the SARUA mapping study initiative *Climate Change Counts*, country consultations were held at the University of Dar es Salaam, Mwalimu Julius Nyerere Main Campus, Dar es Salaam in Tanzania on 25 and 26 September 2013. The workshop was run with a combined group that included university, government, private sector and NGO participants. See Appendix A for the list of participants. A summary of the content of the different sessions is provided below in Table 1. From detailed workshop proceedings captured by a team of three rapporteurs a workshop report was produced, which was circulated to all who participated in the workshop for verification and accuracy. Data produced in the workshops was also verified and added to during plenary sessions. The workshop report forms a substantive basis of the data used for this Country Report, combined with document analysis and questionnaire data.

Table 1: Workshop programme outline

Day 1: 25 September 2013	
08h00 – 08h30	Coffee and registration
08h30 – 09h00	Welcome and Opening remarks: Office of the Vice Chancellor, University of Dar es Salaam
09h00 – 09h30	SARUA Initiative introduction
09h30 – 10h00	SESSION 1: Framing Climate Compatible Development (CCD)
10h00 – 10h30	Tea/coffee
10h30 – 11h30	SESSION 2: Tanzania climate change priorities and needs: Introductory remarks Knowledge and institutional gaps and capacity
11h30 – 13h00	SESSION 3: Group discussion (Breakaway) Tanzania climate change priorities and needs Knowledge and institutional gaps and capacity
13h00 – 14h00	Lunch
14h00 – 15h00	SESSION 3: Plenary report-back and discussion
15h00 – 16h15	SESSION 4: What is the role of the University sector? Identifying other knowledge partners
17h00	Closure of Day 1

Day 2: 26 September 2013	
08h00 – 08h30	Registration for new participants
08h30 – 09h00	Re-cap of Day 1, Agenda for Day 2
09h00 – 10h30	SESSION 5: Breakaway groups and plenary discussion Who is doing what and where in universities in CCD? (Research, Teaching, Community Engagement) Who is doing what and where amongst stakeholder groups? How does this respond to the needs and priorities? What are existing university plans? What are the gaps?
10h30-11h00	Tea/coffee
11h00 – 12h00	SESSION 6: Plenary discussion Knowledge co-production introduction and example of transdisciplinary research programme Gaps in enabling environment, and needs for policy and practice support
12h00 – 12h45	SESSION 7: Opportunities for collaboration Policy implications for government, universities and donors
12h45 – 13h00	SESSION 8: Way forward Closure
13h00 – 14h00	Lunch

2.1.3 Questionnaires

Two different questionnaires were prepared to obtain more in-depth data on climate change and CCD knowledge co-production practice and possibilities, and to enable people who were unable to attend the country workshops to participate in the mapping study (see Appendices C and D). One was designed for university professionals, and the other for national and regional stakeholders who are involved in climate change and CCD. For Tanzania, a total of 40 questionnaires were answered, which included 24 stakeholders and 16 university professionals. Questions covered the following areas:

2.1.3.1 University staff questionnaire

A. **General demographic and professional information** (name, gender, highest qualification, job title, years of experience, years of experience with CC, name of university, country, faculty, department, programme, contact details)
B. **Understandings of Climate Change and Climate Compatible Development** and views on critical CCD issues and responses from universities (staff and university leaders)
C. **Capacity, knowledge and research gaps** (levels of involvement in CC and CCD research – local, national and international; levels of single, inter- and transdisciplinary involvement in CCD

research; stakeholder involvement; funding and fundraising for CCD research; policy contributions; major research programmes / projects; active researchers; research knowledge networks)

D. **Curriculum, teaching and learning** (specialist courses; integration of CCD issues into courses; cross faculty teaching; inter- or transdisciplinary teaching approaches; service learning approaches; critical thinking and problem solving approaches; social or technical innovation courses; assessment and examination of CCD issues; staff willingness and staff ability; actual courses and teaching methods)
E. **Policy, community engagement and student involvement**
F. **University collaboration** (inside the university; between universities in country; with partners; regional and international involvement)
G. **University policy and campus management**

2.1.3.2 Stakeholder questionnaire

The stakeholder questionnaire covered items A-C above, with an additional:

H. **Interests, policies, networks and Centres of Excellence or Expertise**

2.2 Limitations of the mapping study

This mapping study was constrained by a lack of baseline data on knowledge and research gaps for climate compatible development and university-based responses in Tanzania, and by time and resource constraints that did not allow for **in-depth field visitation, individual interviewing or observation** before, during and after the consultation process. Moreover, the information generated at the country workshop relates to the number of participants, their expertise and the number of different sectors and institutions present. Further, while every effort was made to obtain questionnaire responses from as wide a range of stakeholders as possible, and follow-ups were made post-workshop to enhance this, the range of questionnaire responses obtained does provide certain limitations to the data set. However, the **best available information was carefully consolidated, reviewed and verified** in the construction of this mapping study Country Report. Overall, the mapping study was further constrained by a budget cut imposed mid-way through the study.

While much information could be obtained on climate change- and CCD-related knowledge gaps, research needs and capacity gaps, there is obviously more to be learned about these. Similarly, as much information as possible was obtained on 'who is doing what' and on existing research, knowledge co-construction practice and possibilities, but there is clearly also more to learn about these. This mapping study Country Report therefore presents as a useful 'initial document' and it is hoped that Tanzania, and in particular, University of Dar Es Salaam; Mkwawa University College of Education, Dar es Salaam University College of Education, University of Dodoma, Sokoine University of Agriculture, University of Iringa, State University of Zanzibar, the Open University of Tanzania, Muhimbili University of Health and Allied Sciences together with the Vice President's Office, the Ministry of Natural Resources and Tourism, the Ministry of Agriculture, Food Security and Cooperatives, the Ministry of Education and Vocational Training and other national stakeholders,

can take this analysis forward in ongoing mapping and planning activities related to CCD research and knowledge co-production.

2.3 Expanding the mapping study

There are numerous ways to expand this study, most notably by administering the questionnaires (included in Appendices C and D) in a manner that would include every academic at Universities in Tanzania, and in a way that would allow for aggregate data within and across Faculties and Departments. The scope of such a detailed analysis lay beyond the capacity of the current mapping study. Data from questionnaires is therefore indicative rather than conclusive. Similarly, the questionnaire for stakeholders can be administered with additional national and local stakeholders (Appendix D) involved in environment and development initiatives in Tanzania to understand the full scope of climate change and CCD responsiveness in Tanzania, and to further develop the knowledge co-production capacity for CCD in Tanzania. In many ways therefore the SARUA study, as reported in the Country Report, maps out the pathway forward for more detailed and ongoing reflexive analysis of CCD knowledge co-production capacity in Tanzania, and through the questionnaires and analysis provided for in this document, begins to provide for ongoing monitoring and development capability for CCD knowledge co-production in Tanzania. Ministries who could take this study forward could include the Vice President's Office, the Ministry of Natural Resources and Tourism, the Ministry of Agriculture, Food Security and Cooperatives, the Ministry of Education and Vocational Training together with other relevant partners and stakeholders.

2.4 Analysis logic

The analysis logic informing this Country Report is threefold. It firstly maps out a 'needs analysis' which identifies country based knowledge, research and capacity gaps for key CCD priorities as articulated in documents, workshop and questionnaire responses. Secondly, it provides an 'institutional analysis' providing insight into existing institutional capacity for CCD knowledge co-production. Thirdly, it provides a perspective not only on existing knowledge co-production practice for CCD in Tanzania, but also on knowledge co-production possibilities, based on information gathered during the mapping study. It provides a knowledge base for producing knowledge co-production pathways in Tanzania, which may also assist Tanzania **to co-operate with other SADC countries in regional knowledge co-production processes.**

3 NEEDS ANALYSIS

3.1 Introducing the needs analysis

The needs analysis starts with a brief overview of Tanzania's socio-economic context, which provides the baseline for addressing the climate change-related needs and priorities in the country (section 3.2), and a summary of the observed and projected climatic changes for the country (section 3.3). This is followed by an overview of the broader priorities for addressing climate change as identified by policy (section 3.4.1), in workshops (section 3.4.2) and via the questionnaires (section 3.4.3). The needs analysis then moves on to describe more specific priorities and needs, and their associated knowledge, research and capacity gaps (section 3.5). A summative discussion of the needs analysis is provided in section 6.1.

The following differentiation of knowledge, research and capacity gaps is used:

- **Knowledge gaps** (e.g. insufficient knowledge of appropriate CCD technologies);
- **Research gaps** (e.g. no research on cultural uptake of CCD technologies);
- **Individual capacity gaps** (skills needed) (e.g. for technicians / systems thinking etc.); and
- **Institutional capacity gaps** (which have inferred knowledge and research gap implications) (e.g. resources to implement large scale technology change programmes).

It is possible that this analysis can be extended in future, and readers of the mapping study are advised to use the information provided here as best available information (produced within the constraints of the mapping study outlined above), rather than as definitive.

3.2 Socio-economic context

Tanzania lies between latitudes 1°S and 12°S, and between longitudes 30°E and 41°E. Located between the Great Lakes of Victoria, Tanganyika and Nyasa, it has a total area of 945 000 km². Forests and woodland occupy 50 percent of the total area, with wildlife reserves and national parks comprising 25 percent. Except for the coastal belt lying along the 800 km coastline, most of the country is part of the Central African plateau, which lies between 1 000 to 3 000 metres above sea level. Tanzania's climate ranges from tropical to temperate in the highlands. Mean daily temperatures are between 24°C to 34°C, with mean annual rainfall varying from below 500 mm to over 2 500 mm annually, largely depending on altitude. Both of Tanzania's rainfall regimes (bimodal and unimodal) include a long dry season from May to October. Natural hazards include both drought and flooding.

In the early 2000s the Gross Domestic Product (GDP) grew at an average rate of 4 percent per annum, with a population growth rate of 2.8 percent per annum. Agriculture contributes 49.6 percent of the GDP (and 60 percent of export earnings), the services sector 36.4 percent and manufacturing 8.1 percent. The estimated share of the informal sector to the GDP is 32 percent.

Agricultural products include coffee, sisal, tea, cotton, pyrethrum, cashew nuts, tobacco, cloves, corn, wheat, cassava, bananas, and vegetables; most farmers are smallholders relying on rainfed agriculture for their livelihoods. Tanzania is one of the poorest countries in the world with a GNI per

capita of only US $3 001. The total population of the country is estimated at over 43,7 million people, 35 percent of which are living below the poverty line.

3.3 Observed and projected climatic changes, impacts and vulnerabilities

3.3.1 Observed climatic changes

The NAPA notes that the country is already experiencing the effects of climate change, including frequent and severe droughts leading to serious food shortages. East Africa has experienced warming of 0.7°C over the 20th century, and there is evidence that mean annual temperatures in Tanzania have increased by 1°C since the 1960s, experiencing relatively small increases in hot days and much larger increases in the frequency of hot nights during the same period.[10] Observations of precipitation patterns also reveal statistically significant decreasing trends (McSweeney 2009), as well as increasing inter-annual rainfall variability. Seasonal shifts in rainfall patterns have been observed in most parts of the country. An increase in the frequency and severity of floods, droughts and tropical storms has further been observed in Tanzania.

3.3.2 Projected climatic changes

Climate change models predict that temperatures could increase by 1 to 2.7°C by the 2060s, and 1.5 to 4.5°C by the 2090s. All projections indicate increases in the frequency of days and nights that are considered 'hot' in current climate, as well as decreases in the frequency of days and nights that are currently considered 'cold'. Projections are generally for increased rainfall along with an increase in the proportion of rain that falls in heavy events. According to the INC, areas with a bimodal rainfall pattern will have increased rainfall ranging from 5 – 45 percent, while areas receiving unimodal rainfall will experience a reduction of from 5 – 15 percent. While there are no precise predictions of sea level rise for Tanzania, the IPCC has predicted a global average sea level rise of between 18 and 89 cm by 2100. Impacts on the Indian Ocean are expected to be highly variable, and impacts on Tanzanian coastline and islands are also uncertain, due to variables such as currents and modifications of tidal patterns and overall regional climatic patterns.

3.3.3 Impacts and vulnerabilities

The dependence of the majority of Tanzania's population on natural resources for their livelihoods translates into high levels of vulnerability to the impacts climate change, which is compounded by poverty, population density, and environmental degradation. Should Tanzania fail to address the impacts of climate change in the agriculture sector, the nation's GDP could decline by 0.6 to 1

[10] McSweeney, C., M. New and G. Lizcano. 2012. "UNDP Climate Change Country Profiles: Tanzania." Available at http://www.geog.ox.ac.uk/research/climate/projects/undp-cp/index.html?country=Tanzania&d1=Reports, accessed 17 September 2013; and McSweeney, C., M. New, G. Lizcano and X. Lu. 2010. "The UNDP Climate Change Country Profiles Improving the Accessibility of Observed and Projected Climate Information for Studies of Climate Change in Developing Countries," *Bulletin of the American Meteorological Society* 91, 157-166.

percent in 2030; the effects of climate change post-2030 on Tanzania are predicted to be extreme. [11] Tanzania's drought of 2006 devastated agricultural production and is estimated to have cut GDP growth by 1 percent.

According to the INC, vulnerable sectors include agriculture, water resources, forestry, grasslands, livestock, coastal resources and wildlife and biodiversity. The particular vulnerability of coastal zones threatens natural ecosystems, infrastructure and agriculture. The runoff of three major rivers will be altered: in the Pangani and Ruvu rivers, runoff will decrease by 6 – 10 percent while in the Rufiji River runoff will increase by 5 – 11 percent. Reduced runoff of the economically important Pangani and Ruvu rivers, which supply water and hydro-electricity to major towns, would adversely affect socio-economic activities in the country. The five regions supplied are Dar es Salaam, Coastal, Tanga, Kilimanjaro and Arusha. In areas where rainfall will increase, the leaching of nutrients, washing away of the topsoil and water logging will affect plant development and yield. Climate change would favour the occurrence of disease and pests, due to the higher temperatures and increased rainfall. Coffee will most likely be grown successfully where rainfall would increase, while cotton growing areas would be reduced. The maize yield could be reduced by 33 percent over the entire country.

Mount Kilimanjaro's glacier has been reduced by 80 percent since 1912 and it is projected that the entire glacier will be lost by 2025. Further observed impacts include the intrusion of sea water into water wells along the coast of Bagamoyo town and the inundation of Maziwe Island in Pangani District.

Warming temperatures are projected to cause more frequent and more intense extreme weather events, such as heavy rainstorms, flooding, fires, tropical storms and El Niño events. Sea level rise due to climate variability and change has caused degradation of various ecosystems and physical infrastructure along the Tanzanian coast over the last decades. Coastal erosion has resulted in the loss of tracts of land along the coast. Increased winds and storms in the coastal zone are expected to accelerate coastal erosion. Major coral bleaching events in 1998 on the reefs of Zanzibar and Dar es Salaam led to the destruction of natural fish habitat. Dar es Salaam is already prone to flooding and sections of the 2,6 km protective sea wall are severely degraded or destroyed.

3.4 Identified needs: Short to medium term national priorities for CCD in Tanzania

Section 3.4 focuses on the broad priorities and needs for addressing climate change and moving towards CCD in Tanzania. Section 3.4.1 highlights key priorities and needs articulated in policy and strategy, after which some of the broader priorities articulated by workshop participants are discussed in section 3.4.2. This is followed by a presentation of the broader needs for CCD as specified in the questionnaire responses (section 3.4.3). A summative perspective on the broader identified needs for adaptation, mitigation and, ultimately, for CCD, is provided in section 6.1.

[11] International Institute for Environment and Development (IIED). 2009. "Cultivating Success: the need to climate-proof Tanzanian agriculture." Retrieved from http://www.iied.org/pubs/pdfs/17073IIED.pdf

3.4.1 Identified adaptation and mitigation priorities articulated in policy and strategy

3.4.1.1 Adaptation

Tanzania's NAPA undertakes an assessment of vulnerabilities and adaptation options by socio-economic sector, and identifies a number of adaptation options for each, as summarised below:

- ***Agriculture sector*:** Impacts include unpredictable rainfall, shifting agro-ecological zones, increased dry periods, and decreases in maize yields due to temperature rise. Adaptation options in the agriculture sector include alternative farming systems, use of indigenous knowledge, increased irrigation, crop switching, shifting crops to better-suited agro-ecological zones, and utilising climate and weather data to guide farming practices.
- ***Livestock sector*:** Rising temperatures and increased precipitation could cause changes in plant species distribution, and livestock deaths during heat waves. Adaptation options include altering land use patterns, tsetse fly control, pest and disease control measures, research and development, and confining the movement of livestock.
- ***Forestry sector*:** Impacts of climate change on forestry could include deforestation and desertification, more frequent forest fires, the disappearance of medicinal plants, reduced seed dispersal, and a decline in employment and foreign exchange earnings. Adaptation options include promotion of different sources of energy, encouragement of forest regeneration, instituting participatory forest management, creation of community forest fire prevention plans, and afforestation programmes.
- ***Water sector*:** Impacts in the water sector are expected to include decreased and/or increased runoff in river basins, water pollution, and disturbances of stream ecosystems. Adaptation measures include improved water resources management, creation of water reservoirs, and the development of water recycling and re-use facilities.
- ***Coastal and marine resources*:** Impacts of anticipated sea level rise include land losses, coastal erosion and damage to coastal infrastructure, and loss of coastal and marine habitats. Adaptation options in this sector include raising awareness of the impacts of climate change; relocation of services and existing coastal infrastructure; and establishment of protected areas.
- ***Health sector*:** Impacts could include higher incidences of malaria, emergence of malaria in high altitude areas, and severe shortages of food and increases in malnutrition rates. Adaptation options include: strengthening malaria control programs; improving community awareness programs; development of early warning systems; and ensuring the availability of trained health staff.
- ***Wildlife sector*:** Possible impacts of climate change include shrinking wildlife habitat and the disappearance of wildlife corridors. Adaptation options could include combating illegal hunting and forest fires, establishing wildlife information databases, and enhancing capacity building on wildlife management for sustainable development.
- ***Industry sector*:** Variable rainfall and increased drought could lead to shortage of raw materials, power supply, and water supply. Adaptation measures could include the promotion of energy efficiency technologies, promotion of industrial self-energy production, and cleaner production technologies.
- ***Energy sector*:** Impacts on the energy sector could include vulnerability of biomass and hydro power given declines in precipitation and increased evaporation. Adaptation options

include investing in alternative energy sources, development of community-based mini-hydropower, and supporting programmes to develop alternative sources of energy.

- ***Human settlement sector*:** Impacts include coastal erosion and loss of settlements in coastal areas, loss of infrastructure, and migration of people and livestock to other areas. Adaptation options include relocation of vulnerable communities to other areas, establishment of good land tenure systems, awareness raising activities, and the establishment of disaster planning entities at the village level.
- ***Tourism sector*:** Impacts on the tourism sector include shift in preferences from important tourist destinations (Serengeti) to less important areas, coral bleaching, reduced marine biodiversity, and submerging of small islands (Zanzibar, Maria, Kilwa) which are important tourist destinations. Adaptation options include the relocation of people living in wildlife corridors, development of buffer zones around national parks, and the establishment of alternative sources of income for communities in the tourist area.
- ***Land use sector*:** Impacts include soil erosion, degradation of soil structure, declining soil fertility, variability of rainfall, floods and drought affecting land management. Adaptation measures include encouraging terracing and contour farming, use of organic manure, zero grazing, and specific land uses allocated for various development and informal sectors.

Most of Tanzania's 14 prioritised NAPA projects concern agriculture and water resources management (irrigation, water saving, rainwater collection); however, energy and tourism also play an important role. As Tanzania is a Least Developed Country (LDC), the 2012 National Climate Change Strategy (NCCS) emphasises adaptation as the highest priority for the country, and sets out adaptation strategies that build on those in the NAPA. Adaptation strategies in the NCCS are developed for water resources, coastal and marine environment, forestry, wildlife, agriculture and food security, human health, tourism, energy, industry, livestock, fisheries, infrastructure, human settlements, and land use.

Barriers to adaptation

Overarching barriers to adaptation identified are financial and capacity constraints, lack of public awareness, and technological constraints and needs.

3.4.1.2 Mitigation

The NCCS establishes a case for achieving sustainable development while participating in mitigation initiatives, such as the Clean Development Mechanism (CDM), Nationally Appropriate Mitigation Actions (NAMAs), REDD+, and other carbon markets or trading activities. Despite its negligible GHG emissions, the NCCS highlights that Tanzania can participate in mitigation activities to contribute to its sustainable national development. Notably, potential sources of emissions include: traditional energy sources, transportation systems, and waste disposal management activities. In light of the opportunities presented by mitigation initiatives, Tanzania stands to gain financially from the mechanisms, such as CDM, NAMAs, REDD+ and other carbon markets/trading. The mitigation strategies identified in the NCCS include:

- **Energy:** enhancing renewable energy use, promoting diversification of energy sources and developing NAMAs focusing on energy generation and conservation.
- **Industry:** promoting cleaner production, establishing environment and energy management systems, and promoting efficient production technologies.

- **Livestock:** promoting manure management and appropriate technology for animal feedstuff, and improving rangeland productivity.
- **Transport:** promoting fuel switch and enhancing public transport, developing NAMAs on transportation management.
- **Mining:** enhancing cleaner production and exploring capture and storage of GHGs.
- **Waste management:** promoting generation and use of energy from waste, enhancing recycling and developing NAMAs on waste management.
- **Forestry:** promoting afforestation and reforestation, capacity building for community-based forest carbon assessment, promoting REDD+ objectives, and enhancing and conserving forest carbon stocks.
- **Agriculture:** promoting agroforestry, enhancing management of agricultural wastes, and promoting best agronomic practice technologies.

3.4.2 Identified needs associated with CCD articulated in workshop interactions

Participants provided a range of responses during the workshop session dedicated to identifying climate change- and CCD-related needs, which indicated a strong level of engagement with the issue. Participants highlighted the following prioritised needs for potential CCD under three specific categories:

- *Education and Communication*: mainstreaming CC-related aspects into the curricula of the educational system; enhancing the availability of and access to CC information and knowledge;
- *Biodiversity, Ecosystem Services and Tourism*: conservation of habitat for biodiversity management to enhance resilience; strengthening tourism infrastructures; forest ecosystem management; and
- *Agriculture and Food Security*: reduction in crop yields due to climate change; enhancing water resources management to reduce climate risks.

Curriculum development, providing short courses to CC teachers, and other education needs were given high priority both in the workshop and the questionnaires (see section 3.4.3). Detailed needs and gaps related to these broad priorities are presented in section 3.5.1.

3.4.3 Identified needs for CCD articulated in questionnaire data

Questionnaire data showed that while there is a relationship between institutional interest/mandate and/or disciplinary interest/mandate and the definition of priority needs, on the whole Tanzanian stakeholders who completed the questionnaires also tended to highlight more cross-cutting or wide-ranging priorities, regardless of their institutional/disciplinary mandate (see Table 2).

Table 2: Needs identified by different stakeholders / disciplinary specialists (derived from questionnaire data)

Need identified	Institutional interest / mandate and/or disciplinary interest / mandate
Re-think on domestic cooking energy e.g. solar, gas not charcoal, firewood. Controlled livestock keeping. The need of zero grazing. Environmental impact assessment should be practical not political. Poverty cycle interrupted	Geography
Policy harmonisation with respect to CCD. Future projections of good living environment for human wind	Education foundation and management
Serious plans are important. Need for political will	Geography
Capacity building on climate change adaptation to stakeholders in various levels. Enhancing evidence-based policy and decision making across levels of governance and public sectors. Monitoring climate change impacts and develop mitigation strategies	Information Systems
Financial support in implementing various programmes. Collaboration networks on CCD. Improvement of infrastructure to support the established programmes	Geography
We should focus on the change of the attitude of people. Most people (common people) think that the issues of climate are for a particular group of people i.e. climatologists. We need to focus on poverty reduction	Curriculum and Teaching
Adequate knowledge information on the process and its impact. Appropriate effective and efficient interventions in place	Epidemiology and Biostatistics
Stop haphazard harvesting of natural forests and use alternative energy and not charcoal	Environmental and Occupational Health
Promote food security, community awareness about climate change aspects and their impacts e.g. Land degradation, waste management, education for sustainable developments should be integrated into different school curricular and control and reduction of emissions	Curriculum and Teaching
Train experts that will disseminate knowledge to the community	Geography
To build an efficient link to reach various stakeholders in order to create awareness about linkages between climate change and biodiversity. For this, NGOs, research institutions, development partners need to be involved. Establishing network to share information on the wildlife sector in the region and linkages with other sectors of national economies and global initiatives and processes on climate change and variability.	Business Administration and Management
Water resources management and natural resources management in general. Change in energy sources is needed from fuel wood and charcoal to other sources	Geography
Financial organisation. Training, research and innovations	Tourism and Hospitality; Forest Biology
Disaster preparedness plan	GIS Unit

Need identified	Institutional interest / mandate and/or disciplinary interest / mandate
Capacity building and development of mainstreaming climate change to the experts and professionals. This can be done through the Institute for Environment and Sustainable Development (the only institute awarding certificates and diploma in Tanzania)	Directorate of Environmental Information, Communication and Outreach
Tanzania's economic base is agriculture and extraction of natural resources which in most cases are climate dependent. Improving farming, technologies used in extraction of natural resource and improve weather predictions to inform farmers on changes in rainfall patterns to enable them to choose crops, and seed types according to weather conditions.	Urban And Rural Planning (Environment and Climate Change Desk)
Development in Tanzania is done by O and OD where the local community are tasked to prioritise things to be included into to the national budget despite their weak knowledge on climate change which makes them to overlook the issue of climate change. So this necessitates the need to build the capacity of stakeholder to deepen their understanding on climate change	Programmes and Development Department
Promoting Community Based Climate Change Adaptation	Food Governance Research
Address issues on climate adaptation, vulnerability and to some extent mitigation issues	Climate Research
Use of irrigation in agriculture. Drought tolerant varieties. Improvement of infrastructure. Managing and strengthening governmental policies	National Food Security
Access to renewable energy, to the community people, who currently rely on firewood and charcoal, as the main energy for cooking and lighting. Therefore making sure that everybody has access to renewable energy. Changing the current agricultural farming habits (traditional) of cut-and-burn to agroforestry farming skills, which will encourage farming associated with tree planting to combat atmospheric carbon dioxide production To encourage more tree planting, and conserve the existing natural vegetation to combat atmospheric carbon dioxide production. Educate the village population, which constitutes the big percentage illiterate population, on the climate change causes and effects. Most of the remote population believe that the effects of climate change are God given, and are beyond human control, while their agricultural activities contribute to climate change.	Msambara Agroforestry Training and Empowerment Project, Training
The critical aspects to deal with are: Awareness on sustainable utilisation of the existing natural resources. Adaptation and mitigation knowledge on climate change	Programme Officer (Management)
Fight and alleviate poverty while bringing the impact of climate change awareness to the livelihoods at the grassroots. Politicians are not aware of the effects of CC because they do not live there and they take advantage of their ignorance (livelihoods).	Conservation And Cultural Tourism
I will fight climate change and provision the skills and acknowledgement sustainable to community surrounding the areas	General In Environment Conservation

Need identified	Institutional interest / mandate and/or disciplinary interest / mandate
To create more awareness in community on climate change and its impact	Climate Change, Agriculture And Poverty Alleviation
Alternative sources of energy. Forests conservation	Directorate of Sector Co-Ordination
Assessment and reclassification of Agro-ecological biomes at local, regional and national level. Improvement of modelling tools for rainfall and water management. Improved training on analytical tools in climate related streams	Geography
Deliberation on ethical issues impacting on the poor 's knowledge as part of ethical issues	Climate Change Adaptation
Forestry and environmental protection through the application of environmental laws	Climate Change and Environment

Table 2 above shows that stakeholders and university staff observe a wide range of priority needs that require attention for CCD in Tanzania. The diversity of responses shows that different institutions / disciplines and levels of interdisciplinary management shape the perceptions of what the most important climate compatible development 'needs' are. While these do map out along disciplinary or institutional mandates, many respondents also tended to focus on cross-cutting issues, such as the need for awareness raising and better evidence/information, or even issues beyond the apparent disciplinary or institutional orientation of the questionnaire respondent. This is positive for addressing the interdisciplinary and multi-sectoral nature of climate change, and for harnessing skills in Tanzania to address CCD through knowledge co-production.

It is important to identify and recognise these different perspectives in knowledge co-production processes and approaches. Such perspectives also align with the interdisciplinary and multi-sectoral nature of climate change. *How to harness such perspectives, and the associated expertise that informs such perspectives is the ultimate challenge of a knowledge co-production framework and process.*

3.5 Specific knowledge and capacity needs: CCD research, knowledge and individual and institutional capacity gaps (related to CCD priorities)

A second important part of the Needs Analysis undertaken in the context of the SARUA mapping study involved more detailed analysis of CCD knowledge, research and capacity gaps, related to the broad CCD priorities discussed above, with a focus on those identified in key national documents, and as articulated by stakeholders and university staff attending the workshops and completing questionnaires. These specific knowledge, research and capacity gaps, distilled from all three data sources, are discussed in this section.

3.5.1 Needs analysis: Specific research needs and knowledge gaps

Regarding data from the workshop, the prioritised needs for CCD were developed through a combination of themes emergent in the workshop data. Workshop participants systematically identified knowledge, research and capacity (individual and institutional) gaps in relation to selected

priorities under certain thematic areas. The thematic areas were developed based on the areas of interest and expertise of participants, and thus cannot necessarily be considered as rigorously developed priorities for the country. However, within these thematic areas, participants identified what they considered to be priority issues that needed to be addressed in order to respond better to the country's climate change challenges. The thematic areas focused on in the Tanzania workshop were the following:

- Education and Communication;
- Biodiversity, Ecosystem Services and Tourism; and
- Agriculture and Food Security.

Table 3 lists knowledge, research and individual and institutional capacity gaps for selected priorities under the four thematic areas, as identified by workshop participants.

Table 3: Knowledge, research and individual and institutional capacity gaps identified by workshop participants

Prioritised needs for CCD	Knowledge gaps	Research gaps	Individual capacity gaps	Institutional capacity gaps
Mainstreaming CC – related aspects into the curricula of the educational system	▪ Inadequacy of specific curricula content on CC-related issues	▪ Survey on specific content to specific level ▪ Assessment of CC curriculum implementation at various levels	▪ Inadequate competent trainers/teachers in CC related issues	▪ Inadequate CC course curricula at various levels ▪ Inadequate teaching facilities and tools on CC
Enhancement of the availability of and access to CC information and knowledge	▪ Limited information on CC in educational institutions	▪ Research on effective ways of accessing and sharing of CC information and knowledge	▪ Database managers and CC information service providers	▪ Limited CC databases, institutional repositories and information centres on CC
Conservation of habitat for biodiversity management to enhance resilience	▪ Limited knowledge to suit current situation ▪ Inadequate evidence/ baseline information to persuade stakeholders ▪ Inadequate baseline information/data/long-term data/time series data	▪ Research on how different species respond to climate change ▪ Survey of species distribution on different habitats in the context of CC ▪ Research on knowledge of conservation of habitat/modelling/projection ▪ Updating information	▪ Limited awareness on importance of habitat conservation in the context of CC ▪ Lack of skills – informed managers, researchers, service providers, modellers	▪ Poor coordination on issues of CCD on government ▪ Limited understanding of relationship between issues of habitat health and climate change ▪ Limited multi-sectoral coordination ▪ Inadequate institutional arrangements
Strengthening tourism infrastructures	▪ Inadequate knowledge of balancing between conservation and tourism development ▪ Limited CC database to inform sustainable development of tourism infrastructure	▪ Studies on tourism infrastructure development in the context of CC ▪ Tourism policy analysis and harmonisation in the context of CC	▪ Limited policy analysts in the tourism sector ▪ Inadequate CC expertise in the tourism sector	▪ Conflicting institutional mandates within the tourism sector ▪ Inadequate local community participation in the management of the tourism sector

Prioritised needs for CCD	Knowledge gaps	Research gaps	Individual capacity gaps	Institutional capacity gaps
Forest ecosystem management	▪ Limited knowledge of managing forest fires in the context of CC ▪ Unclear knowledge on rate of GHG emissions due to deforestation and forest degradation	▪ Limited research on forest fire management in the context of CC ▪ Inadequate ecosystem based adaptation studies ▪ Poor documentation on rates of forest degradation	▪ Inadequate fire modelling experts in forest ecosystem management in the context of CC	▪ Inadequate allocation of funds to forest sector ▪ Inadequate sectoral collaboration ▪ Limited institutional collective responsibilities in the context of CC
Reduction in crop yields due to climate change	▪ Knowledge on reasons for unstable production trend ▪ Inadequate awareness on climate change ▪ Inadequate knowledge on weather prediction ▪ Knowledge on improved agronomy practices ▪ Causes / likelihood of ecological shifts, related to climate change	▪ No research information on high yielding and CC tolerant crops ▪ Inadequate information of new and old diseases ▪ Available data is not harmonised ▪ Assessment of ecological zones at local scale	▪ Inadequate expertise in climate change and agriculture ▪ Lack of analytical tools among agricultural researchers, extension officers and agronomists	▪ Inadequate agricultural research centres ▪ Lack of centralised database ▪ Inadequacy of integrating climate change in agricultural plans, programmes, policies and strategies ▪ Mechanisms to promote sustainability of projects ▪ Inadequacy of funds
Enhancing water resources management to reduce climate risks	▪ Lack of technology on: ▪ Water harvesting technology ▪ Irrigation ▪ Management of catchment areas ▪ Water use modelling	▪ Inadequate research on water resistant crops ▪ Lack of research on irrigation	▪ Inadequate expertise on water management systems and catchment protection ▪ Inadequate awareness of available by-laws and laws governing water resource management	▪ Lack of information sharing ▪ Poor policy harmonisation (e.g. water policy, irrigation policy, forest policy, etc) ▪ Unsustainability of development projects

Overall, workshop participants highlighted a general lack of knowledge with regard to climate change and CCD. Specific **knowledge gaps** focused on improving the curricula content relating to climate change and CCD. *Information and data-related gaps* include inadequate baseline information, lack of long-term data and time series data, inadequate climate projections and weather prediction, need to digitise data that does exist, and lack of a climate change data base to house relevant information. Other specific knowledge gaps raised included understanding the balance between conservation and tourism development; unclear knowledge on rate of GHG emissions due to deforestation and forest degradation; knowledge on improved agronomy practices and a need to improve technological knowledge.

Prioritised **research gaps** included a number of social and methodological issues like the need for an assessment of climate change curriculum implementation at various levels, as well as research on effective ways of accessing and sharing climate change information and knowledge. Biodiversity research required focused mainly on the effects of climate change on species resilience and distribution, and on specific conservation measures. There was also a focus on tourism infrastructure development, as well as an examination of tourism policy in the context of climate change. Research into deforestation rates and high yielding and climate change tolerant crops was also specified. Overall there was a call to harmonise and consolidate research efforts in Tanzania.

Overall a wide range of needs were identified, focusing on alternative energy for rural communities, curriculum development, awareness raising at various levels, encouraging political will in CCD, policy enhancement, disaster management, financial support, community based adaptation and professional development in climate change and CCD related fields. Workshop discussions also highlighted the cultural aspects of adoption of new and climate-resilient technologies, as expressed in the following quotation.

> *"There is also the issue of cultural aspects of adoption. Remember there was a very concerted effort by the British colonial government to introduce sorghum in central Tanzania and those other dry areas. But people could not adopt these crops – and today everyone is farming maize."*
>
> Tanzania university staff member

The individual and institutional capacity gaps identified in Table 3 are further discussed in sections 3.5.2 and 3.5.3.

The mapping study identified a number of programmes and projects involving government and donor agencies that are specifically focused on addressing climate change challenges, and which include research needs (implicit or explicit) that would need to be addressed through knowledge co-production involving multi-stakeholders at different levels, as shown in Table 4 below. Some suggestions are provided for research and knowledge gaps that may be at least partially addressed by these programmes.

Table 4: Some climate change programmes in Tanzania, with potential associated research needs

Project/programme	Partner organisations – potentially for knowledge co-production	Potential associated research needs, linked to specific knowledge needs (as indicated in policy (P), supplemented by workshop (W) and questionnaire data (Q))
Establish a Knowledge Management system on CC adaptation; and to use CCA knowledge and experiences to inform national and regional policies and interventions at community level (P)	LEAD AGENT: ▪ Vice President's Office, Department of Environment (VPO-DOE) PARTNERS ▪ UNDP Government of Japan	▪ Research on effective ways of accessing and sharing of CC information and knowledge (W)
Implementation of Concrete Adaptation Measures to Reduce Vulnerability of Livelihoods and Economy of Coastal and Lakeshore Communities in Tanzania	LEAD AGENT: ▪ Vice President's Office, Department of Environment (VPO-DOE) PARTNERS: ▪ UNEP, Adaptation Fund	▪ Produce Ecosystem-based Integrated Coastal Area Management Plan (P) ▪ Research on knowledge of conservation of habitat/modelling/projection (W) ▪ Inadequate evidence/ baseline information to persuade stakeholders (W) ▪ Inadequate baseline information/data/long term data/time series data (W) ▪ Insufficient knowledge on the part of the general public on how climate change could impact on their lives and livelihoods (P)
Mainstreaming climate change in integrated water resources management in Pangani River Basin 2008-2011 Piloting with field-based adaptation measures with strong links to basin and national planning and policy Technical reports produced on aspects of the Pangani system, e.g. hydroelectric power modelling, fisheries, vegetation, hydraulic modelling, climate change modelling, macro-economics; plus lessons learned for scaling up	LEAD AGENT: ▪ Govt of Tanzania PARTNERS: ▪ UNDP ▪ IUCN ▪ GEF-Special Climate Change Fund (SCCF)	▪ Lack of knowledge regarding water harvesting technology, irrigation management of catchment areas and water use modelling (W) ▪ Undertaking of inter-basin water transfer studies in relation to the climate change scenarios developed (P)

Project/programme	Partner organisations – potentially for knowledge co-production	Potential associated research needs, linked to specific knowledge needs (as indicated in policy (P), supplemented by workshop (W) and questionnaire data (Q))
Food Governance Research: (Q) Climate change dialogues in five districts within the Lake Victoria Basin in collaboration with St Augustine University of Tanzania Capacity Building for Natural Resources and Agricultural extension staff in five districts in the Lake Victoria Basin (Q)	LEAD AGENT ▪ Governance Links Tanzania PARTNERS: ▪ St Augustine University of Tanzania	▪ Linking research, capacity building and community level responses (Q)
Climate Change Impacts, Adaptation and Mitigation programme (CCIAM) in Tanzania 2009-2014 Through research projects, capacity building, documentation, awareness raising and outreach, CCIAM focused on enhancing a greener environment by promoting natural forest conservation, afforestation, reforestation and better agricultural practices for improved livelihoods related to the Reduced Emissions from Deforestation's and Forest Degradation (REDD) initiative	LEAD AGENT: ▪ TMA/ SUA, National Food Security. PARTNERS: ▪ CCIAM project which is conducted in collaboration with SUA, UDSM, ARDHI and TMA and UMB from Norway [Norwegian University of Life Sciences through its Department of International Environment and Development Studies (Noragric)]	▪ To strengthen central forecasting office in order to provide/improve medium range and seasonal forecast. To promote capacity building in research and environmental section (Q) ▪ Knowledge on reasons for unstable production trend (W) ▪ Inadequate awareness on climate change Inadequate (W) ▪ knowledge on weather prediction (W) ▪ Knowledge on improved agronomy practices Causes / likelihood of ecological shifts, related to climate change (W)

Table 5 provides a more detailed overview of the research and knowledge needs associated with CCD in Mauritius, drawing on all three data sources.

Table 5: More detailed research and knowledge needs from Tanzanian policy documents, workshop and questionnaire data

Description of research and knowledge needs
Aspect A: ADAPTATION Food Security and Agriculture ▪ Impacts on the agricultural systems (P) ▪ Studying and disseminating new technologies and management systems that improve on the indigenous knowledge of the agro-pastoralist and pastoralist (P) ▪ Continuous assessment of climate change impact on grassland and livestock particularly in the country's marginal regions to ascertain ways to increase and sustain livestock production with minimum environmental degradation (P) ▪ Studies on livestock that are more tolerant to diseases and drought (P) ▪ Research on agro-chemicals to counter diseases and pests that would probably increase with climate change (P) ▪ Research on the development of pasture and tree fodder crops to enhance the sustainability of livestock and dairy cattle if climate changes occur (P) ▪ Knowledge on reasons for unstable production trend (W) ▪ Inadequate awareness on climate change (W) ▪ Inadequate knowledge on weather prediction (W) ▪ Knowledge on improved agronomy practices (W) ▪ Causes / likelihood of ecological shifts, related to climate change (W) ▪ No research information on high yielding and CC tolerant crops (W) ▪ Inadequate information of new and old diseases (W) ▪ Available data is not harmonised (W) ▪ Assessment of ecological zones at local scale (W) Water Resources ▪ Testing of modified General Circulation Models and analysing the resulting climate change scenarios and impacts for comparison with current predicted climate change results (P) ▪ Incorporation of climate change scenarios in the hydrology and geology of the country (P) ▪ Undertaking of inter-basin water transfer studies in relation to the climate change scenarios developed (P) ▪ Lack of technology on water harvesting technology and irrigation (W) ▪ Management of catchment areas (W) ▪ Water use modelling (W) Infrastructure and Health ▪ Insufficient knowledge of climate change impacts on human health (P) ▪ Insufficient knowledge on vulnerability patterns and adaptive capacity (P) ▪ Detailed assessment of the climate change impacts on malaria and the adaptation responses (P) ▪ Research on feasible and viable chemical and biological control options to counteract malaria as climate change occurs (P) ▪ Socio-economic analysis of the adaptation responses that are feasible (W) ▪ Vulnerability assessment in terms of human settlements both in urban and rural areas, infrastructure and basic services provision especially in urban areas (Q) ▪ Research is needed on how climate change affects communities especially those near forests reserves by clearing forest for agriculture expansion (Q)

Description of research and knowledge needs

Biodiversity and Ecosystem Services

- Research on sustainable and integrated natural resources management technologies (P, Q)
- Improvement of the models and analytical methods used to assess the impacts of climate change on forest in order to include more parameters (P)
- Continued research on the vulnerability of climate change to forest (P)
- Conducting research to identify plant species that are adaptable to climate change (P)
- Development of the improved use of forests and forests products (P)
- Further research on the impacts of climate change on the terrestrial biodiversity and habitat (P)
- Study of the impact of climate change on endangered and endemic species to see how these will cope with global climate change (P)
- Limited knowledge to suit current situation (W)
- Inadequate evidence/ baseline information to persuade stakeholders (W)
- Inadequate baseline information/data/long term data/time series data (W)
- Research on how different species respond to climate change (W)
- Survey of species distribution on different habitats in the context of CC (W)
- Research on knowledge of conservation of habitat/modelling/projection (W)
- Updating information (W)
- Limited knowledge of managing forest fires in the context of CC (W)
- Unclear knowledge on rate of GHG emissions due to deforestation and forest degradation (W, Q)
- Limited research on forest fire management in the context of CC (W)
- Inadequate ecosystem based adaptation studies (W)
- Poor documentation on rates of forest degradation (W)

Tourism

- Inadequate knowledge of balancing between conservation and tourism development (W)
- Limited CC database to inform sustainable development of tourism infrastructure (W)
- Studies on tourism infrastructure development in the context of CC (W)
- Tourism policy analysis and harmonization in the context of CC (W)

Sea Level Rise and Coastal management

- Undertaking Aerial Videotape-Assisted Vulnerability Analysis along the whole coastline of Tanzania and assessing the impacts due to sea level rises and storm surges (P)
- Undertaking detailed studies of wave, climate and sediment transport in order to estimate erosion; and salinity and temperature variations necessary to predict sea level rise (P)
- Valuation of all the vulnerable structures along the entire coastline (P)

Aspect B: MITIGATION

Sustainable Energy and Low Carbon Development

- Further developing baseline information in relevant areas such as GHG emissions (P)
- Research into the environmental impacts of energy-related developments (P)

Aspect C: CROSS-CUTTING ISSUES

Education and Communication

- Insufficient knowledge on the part of the general public on how climate change could impact on their lives and livelihoods (P, Q)
- Lack of knowledge on effective methodologies for communicating climate change (P)
- Lack of understanding of how indigenous knowledge may contribute to adaptation and mitigation (P, Q)

Description of research and knowledge needs
▪ Inadequacy of specific curricula content on CC-related issues (W) ▪ Survey on specific content to specific level (W) ▪ Assessment of CC curriculum implementation at various levels (W) ▪ Limited information on CC in educational institutions (W) Public awareness, participation and access to information ▪ Lack of public awareness, and knowledge among policy makers and people in government (Q) ▪ Climate change and Gender (Q) ▪ Research on effective ways of accessing and sharing of CC information and knowledge (W) ▪ Research and information needs, including how to use climate change information [see Table 3 above] Economics of Climate Change ▪ Lack of knowledge regarding the economics of Climate Change in Tanzania (Q) Technology Development and Transfer ▪ Research into improved knowledge storage, data-base, knowledge transfer systems (Q) Legislative Development • Development and implementing local climate change adaptation plans within local government frameworks (Q)

Note: As in Table 4, additions from workshop (W), questionnaire (Q) and policy (P) data are indicated in brackets.

The table above offers some indication of where the major needs are, which is of relevance for the implementation of Tanzania's National Climate Change Strategy. All of these needs are highly reliant on research and knowledge (co) production processes, and it would be important that the diversity of these knowledge needs should be well articulated in such policy at a suitable level of detail.

What is of interest in this analysis (as presented in Table 5), is that the potential national research and knowledge needs (identified in Table 4) are more nuanced when considered in thematic context. This is an important point to note for knowledge co-production processes, so as not to lose the specificity of the research problems and/or contexts.

The priorities for CCD relating to Biodiversity, Agriculture and Food Security (identified in workshop data, see section 3.3 above) were readily highlighted across the data sets as important areas for knowledge and research. Tourism, education, curriculum development, awareness development and infrastructure expansion were seen as important to not only assist in the move towards CCD in technical ways, but also to engage with the social processes necessary to **implement policies and strategies related to CCD.** There is growing consensus, congruent with the definition of CCD, that adapting to climate change requires iterative and participatory learning processes, for which understanding social learning and triggers for behavioural change are important steps. A further component of addressing process issues related to CCD policy implementation is analysing individual and institutional capacity gaps, as addressed in the following two sections.

3.5.2 Needs analysis: Individual capacity gaps

A range of individual capacity gaps were articulated in the workshop and also set out in Tanzanian policy documents. The INC (2003) notes a list of key capacity gaps present in Tanzania:

- Inadequate expertise to deal with systematic climate change observation;
- Inadequate technology management competencies;
- GIS skills;
- EIA competencies;
- Modern biotechnology;
- Climate modelling;
- Preparation and implementation of CDM projects;
- Inadequate capacity to enforce environmental regulations;
- Financial and resource mobilisation skills;
- Low level of environmental understanding and awareness among politicians;
- Monitoring and evaluation competencies;
- Conflict resolution skills; and
- Range of specialised skills on climate change, biodiversity, and sustainable land management (not spelled out in NCSA).

Key considerations for **i**ndividual capacity development expressed by the workshop participants involved an overall lack of competent trainers/teachers in climate change related issues. The identified limited capacities in information sharing and database management weaken the potential for further competency to be established. Generally, participants felt there was a noticeable lack of climate change and CCD informed managers, researchers, service providers and modellers. Specific capacities called for in the workshop included:

- Awareness on importance of habitat conservation in the context of CC;
- Policy analysts in the tourism sector;
- Climate change expertise in the tourism sector;
- Fire modelling experts in forest ecosystem management in the context of CC;
- Expertise in climate change and agriculture;
- Analytical tools among agricultural researchers, extension officers and agronomists;
- Expertise on water management systems and catchment protection; and
- Awareness of available by-laws and laws governing water resource management.

The wide range of disciplines cited by the 2003 INC as requiring improved **individual capacity**, namely climate change observation, technology management competencies, GIS skills, EIA competencies, biotechnology, Climate modelling, environmental regulations enforcement, financial and resource mobilisation, monitoring and evaluation competencies and conflict resolution skills, related strongly to the workshop participants' concerns for the limited capacities in information sharing and database management and the need for climate change and CCD informed managers, researchers, service providers and modellers.

3.5.3 Needs analysis: Institutional capacity gaps

The policy review revealed the following specific institutional capacity gaps, which were mainly sourced from the INC (2003) and consist of a range of different specific institutional capacity needs:

- Strengthening the weather and climate monitoring system through improvement of observing network and telecommunications, as well as data processing;
- Lack of equipment and inadequate funding for monitoring greenhouse gases and climate observations;
- Lack of financial resources to undertake specific research and interpreting data so that can reach many end users in need of such information;
- Need to enhance cooperation with international bodies particularly, on information exchange;
- Embarking on industrial energy audits and ways of improving energy efficiency;
- Promotion of appropriate and affordable renewable energy technologies;
- Implementation of a national programme to promote renewable energy technologies and energy conservation in Tanzania;
- Development and broad application of integrated malaria control;
- Comprehensive awareness programme targeting the different user groups of the environment;
- Establishing centres of excellence on climate change;
- Climate related libraries and data banks in these centres of excellence, making these institutions depositaries of information; and
- Establishment and strengthening of linkages between R&D institutions, academia and the productive sectors' activities.

The Tanzania workshop and questionnaires identified the need for improved course curricula at various levels; participants also raised concerns over current inadequate teaching facilities and tools on climate change needed to enable this. These included limited climate change databases, institutional repositories and information centres. Poor coordination on issues of CCD at government levels was also scrutinised as a key capacity gap. Conflicting institutional mandates were also cited, with the specific example of that experienced within the tourism sector. In addition to this, participants raised the issue of limited multi-sectoral coordination and collaboration with regards to climate change and CCD; poor policy harmonisation, and the lack of information sharing. Participants also raised specific concerns on the limited understanding of relationship between issues of habitat health and climate change. Funding and the inadequate allocation of existing funds were also seen as a key institutional capacity gap, with the specific example of the forest sector. Some other specific institutional capacities mentioned included:

- Inadequate agricultural research centres;
- Inadequacy of integrating climate change in agricultural plans, programs, policies and strategies; and
- Mechanisms to promote sustainability of projects.

4 INSTITUTIONAL ANALYSIS

4.1 Introducing the institutional analysis

This section describes the current responses of different institutions (higher education, government, NGO/CBO, private sector) to addressing climate change and promoting CCD, within the broad context of the above-mentioned research, knowledge and capacity gaps. Core emphasis is placed on higher education institutions, as it is widely recognised that they have an important role to play in research, education and training, and in providing policy and strategy support and leadership for development.

The institutional analysis begins with a summary of wider institutional arrangements for CCD, including any relevant research and development frameworks. It then discusses some of the current CCD initiatives and programmes in Tanzania, and identifies some of the key stakeholders that could form part of a Tanzanian CCD knowledge co-production framework.

Following that, it examines understandings of CCD amongst stakeholders and university staff, and then begins to probe research practice and capacity, as well as curriculum, teaching and learning programmes and capacity in the higher education sector. It further considers other aspects of higher education interaction with climate change and CCD, namely community engagement, student involvement, policy engagement and campus sustainability initiatives.

4.2 Policy and institutional arrangements

4.2.1 Policy and institutional arrangements governing Higher Education in Tanzania[12]

Higher education in Tanzania dates back to the early 1960s. The first university started as a college of the University of London with a single faculty (Law). In 1963, two years after the college was established, the institution became a component of the University of East Africa, which at the time included Nairobi University College in Kenya and Makerere University College in Uganda. The East African Authority's decision for a split in 1970 resulted in the establishment of Dar es Salaam University College, which later attained full university status to become the University of Dar es Salaam (UDSM). The majority of public institutions can be argued to have derived from the UDSM (Mwollo-Ntallima 2011). These include Sokoine University of Agriculture (SUA), established in 1984 out of the UDSM's Faculty of Agriculture, Forest and Veterinary Science, as well as Mkwawa University College and the Dar es Salaam University College of Education.

[12] This short summary is derived from a SARUA Country Profile compiled by Israel G Mawoyo and Merridy Wilson-Strydom. 2011. "Chapter 14: Tanzania," in *A profile of Higher Education in Southern Africa. Volume 2*. (www.sarua.org)

The Tanzanian education system has a 7–6–3 format: primary education lasts for a period of seven years, followed by six years of secondary education and three years of university education. The secondary level is further divided into two: a four-year period which leads to the ordinary level certificate, and entrance into the upper secondary level, which culminates in the advanced-level certificate and qualification for entry into university education. Upon completion of the advanced level, a student qualifies to enrol for a degree programme at a university or university college. An undergraduate qualification generally lasts for three years, but there are some programmes that take longer (Shaik n.d.). The post-secondary education system is divided into two parts: tertiary and higher. Tertiary education specifically deals with semi-skilled qualifications, and tertiary institutions of learning generally offer certificate and diploma qualifications. Institutions of higher education (which include universities and university colleges), on the other hand, offer highly skilled qualifications. Higher and tertiary education in Tanzania is governed by a number of policies, structures and frameworks aimed at enhancing the sector (SARUA 2009): The Education and Training Policy (1995) covers a number of areas including:

- Equity in access to education;
- Quality control and assurance;
- Partnerships between the state and the private sector in providing education;
- Teacher management and reform; and
- Broadening access.

The Higher Education Policy (1999) focuses primarily on ensuring that there is a council that caters for the needs and demands of the higher education sector. Some of the needs and demands that are to be addressed include: management and control of expansion within the higher education sector; funding: formulating and implementing cost sharing mechanisms; addressing gender imbalances in enrolment and participation rates in the natural sciences; linking higher and tertiary education to the demands of the market; and establishment of private institutions.

During SARUA's previous higher education profiling study (Kotecha 2008) it was noted that this policy was under review. In the present study, the research team sought information about recommendations or changes made to this policy, but no data or clarification was provided. It is likely that this policy has been superseded by the Higher Education Development Programme 2010–2015 (URT 2010) discussed below.

The mandate of the National Science and Technology Policy (1996) is to promote a culture of embracing science and technology in every sector of Tanzanian society. The policy has sixteen objectives which focus on achieving this goal. The Higher Education Development Programme includes other policies such as the Technical Education and Training Policy (1996) and, more recently, the Higher Education Development Programme (HEDP) 2010–2015 (2010). The HEDP explicitly recognises the role of higher education in supporting sustainable social and economic development in Tanzania. Building on the Education Sector Development Programme (ESDP), the HEDP moves the national focus from the development of primary and secondary education to higher education.

Acknowledging that participation rates in Tanzanian higher education have remained 'abysmally low' at only 3 percent and that, although there has been some development in the areas of science, engineering and technology (SET), this has had little impact on people's day-to-day lives (URT 2010: viii), the following developmental objectives are defined: establish a comprehensive and co-ordinated higher education system through institutional reforms; improve delivery of higher education through ensuring relevance and diversification of the curriculum, and increased access, equity and quality; and enhance the capacity of the higher education system so as to maintain and sustain all its functions effectively and efficiently.

Based on a review of the national context and important policy thrusts, it is noted that the HEDP needs to respond to the increased social demand for higher education in Tanzania as well as the following needs (paraphrased from HEDP: 10): increased growth in agriculture, manufacturing and other economic sectors; capacity-building in new and emerging SET areas, including biotechnology, environmental science, molecular biology, nanoscience and informatics; improving capacity in both existing and emerging higher education institutions; ensuring that higher education institutions are more competitive in a globalised environment; increased demand for middle and high-level skills; improved knowledge and entrepreneurial skills amongst the youth; sustainability of higher education by efficient and effective resource mobilisation; addressing and solving problems related to poverty reduction; and addressing cross-cutting issues such a democracy, gender, environment, entrepreneurship, good governance and various infectious diseases.

The implementation of HEDP 2010–2015 is organised around nine areas of focus within three main thematic areas: institutional reforms, service delivery and sustainability mechanisms. The HEDP document provides a detailed account of the expected outputs and outcomes with specific targets set in many cases (URT 2010: x-xi, 11-33). Thus, higher education in Tanzania has been accorded an increasingly important place on the national agenda, and a supportive policy environment has been put in place as the basis from which the sector can grow.

4.2.2 Policy context for climate change

An initial National Action Plan on Climate Change was developed in 1997. While existing environmental planning in the context of the Environmental Management Act, 2004 did address certain aspects of climate change, the need to enhance governance strategies and institutional arrangements to address all aspects of climate change mitigation and adaptation was recognised. In 2012, Tanzania developed the National Climate Change Strategy (NCCS), which includes a gender and climate change strategy. The goal of the NCCS is to enable Tanzania to effectively adapt to climate change and participate in global efforts to mitigate climate change with a view to achieving sustainable development in line with the Five Years National Development plan; the Tanzania Development Vision 2025, as well as national sectoral policies. It is expected that implementation of this Strategy will reduce vulnerability and enhance resilience to the impacts of climate change. Tanzania will implement a National Action Plan (NAP) on climate change. Tanzania has further established a National REDD+ Strategy, to assist in leveraging developmental opportunities offered by the Reducing Emissions from Deforestation and Forest Degradation Plus (REDD+) Mechanism. The country has also developed a National Climate Change Communication Strategy.

4.2.3 Institutional arrangements for Climate Change

The Division of Environment, under which the national coordination of climate change issues falls, is located within the Vice-President's Office. The government has established an inter-ministerial National Climate Change Technical Committee (NCCTC), which comprises permanent secretaries from 13 government ministries. The NCCTC oversees all technical issues related to the implementation of climate change.

The National Climate Change Steering Committee (NCCSC) has the role of guiding the coordination and implementation of the NCCS. The NCCTC provides technical advice to the National Climate Change Focal Point (NCCFP), while the NCCSC provides policy guidance and ensures coordination of actions as well as cross sectoral participation. Tanzania's civil society forum on climate change, Forum CC, plays a role in co-ordinating actions on climate change. A recent assessment by the group indicates that there may be over 100 initiatives related to both climate change adaptation and mitigation in Tanzania[13], and that adaptation actions need to be better coordinated.

Stakeholder engagement: Stakeholders from academia, government, the private sector, and the local level were involved in the development of the 2007 National Adaptation Programme of Action (NAPA), which assisted with the collection of information and climate data, towards overcoming the limited current data base on climate observations and impacts. The National Climate Change Strategy included consultations with various stakeholders, through a national consultation workshop and five zonal workshops, undertaken to collect and collate views from individuals at community level, create awareness on climate change impacts and the need for a Strategy to harmonise ongoing and future activities.

4.3 Research and development frameworks

The National Science and Technology Policy (1996) mentioned above aims to promote a culture of embracing science and technology in every sector of Tanzanian society. Institutionally, the Tanzania Commission for Science and Technology (COSTECH), a corporate public organisation established in 1986 as a successor to the Tanzania National Scientific Research Council, coordinates and promotes research and technology development activities in the country. It is the chief advisor to the Government on all matters pertaining to science and technology and their application to socio-economic development. Nineteen research and development (R&D) institutes are currently affiliated to COSTECH. A zero draft Zanzibar Research Agenda was developed in November 2013; it is not clear whether this includes climate change related fields. The Commission is currently in the process of building a National Research Registry, to assist researchers to identify their colleagues and studies already conducted in a particular field. Given the rise in the number of researchers coming to Tanzania

[13] Hepworth, Nick. 2010. *Climate Change Vulnerability and Adaptation Preparedness in Tanzania*. Nairobi: Heinrich Boll Foundation. Retrieved from http://www.boell.de/downloads/worldwide/Tanzania_Climate_Change_Adaptation_Preparedness.pdf

for research, the Commission will act as a national clearing house of research undertaken by independent foreign researchers in this country.[14] Tanzania's 2010 National Research and Development Policy identifies as a critical issue the ineffective mechanisms for setting up priority research areas that have direct benefits to national economic growth, societal and human welfare. While it does not identify these areas, and does not mention climate change, the policy does highlight the need to facilitate and promote research that has a positive impact on the environment, in addition to benefitting societal welfare.

4.4 Some current CCD initiatives and programmes

While there are a number of CCD initiatives and programmes active in Tanzania, driven by government, NGOs, donors, and the private sector, limitations and the required focus of this institutional analysis meant that only a few of these have been identified. See Table 8 for some of these initiatives. This list is not comprehensive, but rather illustrative of how some of the priorities and needs identified above are already being addressed. More comprehensive national analysis would be able to expand the insights into existing active programmes.

Table 6: Some CCD initiatives and programmes in Tanzania

Programme / Initiative	Driving agency / department	Focus and time frame	Status / additional comments
Supporting integrated and comprehensive approaches to climate change adaptation in Africa - Tanzania Africa Adaptation Programme	▪ Vice President's Office ▪ Department of Environment (VPO-DOE) ▪ UNDP ▪ Government of Japan	2010-2013: ▪ Integrate and mainstream climate change adaptation into the institutional framework and into core development policies, strategies and plans	Aimed to establish a Knowledge Management system on CC adaptation; and to use CCA knowledge and experiences to inform national and regional policies and interventions at community level
Implementation of Concrete Adaptation Measures to Reduce Vulnerability of Livelihoods and Economy of Coastal and Lakeshore Communities in Tanzania	▪ Vice President's Office ▪ Department of Environment (VPO-DOE) ▪ UNEP ▪ Adaptation Fund	2012–2017: ▪ Rehabilitate coastal ecosystems to enhance ecological resistance to flooding; create climate change observatory for Tanzania; produce Ecosystem-based Integrated Coastal Area Management Plan	

[14] According to the Commission's website, most research scientists tend to originate from countries such as USA, Britain, Germany, Japan, Denmark, Finland, Sweden and the Netherlands. Fields of study that attract most foreigners include wildlife and other life sciences, anthropology, sociology, languages and archaeology.

Programme / Initiative	Driving agency / department	Focus and time frame	Status / additional comments
Mainstreaming climate change in integrated water resources management in Pangani River Basin	▪ Government of Tanzania ▪ UNDP ▪ IUCN ▪ GEF-SCCF	2008–2011: ▪ Piloting with field-based adaptation measures with strong links to basin and national planning and policy	Technical reports produced on aspects of the Pangani system, e.g. hydroelectric power modelling, fisheries, vegetation, hydraulic modelling, climate change modelling, macro-economics; plus lessons learned for scaling up
To strengthen central forecasting office in order to provide/improve medium range and seasonal forecast	▪ TMA/ SUA ▪ National Food Security in collaboration with SUA, UDSM, ARDHI and TMA and UMB from Norway	Time frame unknown: ▪ To promote capacity building in research and environmental section	
Cross- Sectoral coordination, through the Environment NRS Programme	▪ Prime Minister's Office Regional Administration and Local Government	Time frame unknown: ▪ PMORALG – sector coordination section has a role of coordination implementation of environment and NRS programme in the local government authorities	Linking with other sectors ministries responsible for environmental NRS management
CCD capacity development in Zanzibar, through the ZCCA	▪ ZANZIBAR CLIMATIC CHANGE ALLIANCE ▪ Collaborating with OSSREA Tanzania chapter(Organisation for social science and research in east Africa) at the University of Dar es Salaam	Time frame unknown: ▪ Focus on Article 6 of the United Nations Frameworks on Climate Change Convention on awareness, education and capacity development	
Tanzania Forest Conservation Group	▪ Tanzania Forest Conservation Group	Time frame unknown: ▪ Climate Change, Agriculture and Poverty alleviation	Project on climate change agriculture and poverty alleviation conducted in Kilosa and Chamusino, Morogoro and Dodoma regions, enabling villagers to engage in climate-smart agriculture

Note: The list is not comprehensive.

Considering these initiatives, which constitute only a small sub-set of action on climate change by Tanzanian organisations, it is clear that there is a focus on coastal, lakeshore and agricultural issues, and an emphasis on concrete adaptation measures. The initiatives involve government departments, universities, donors, NGOs and CBOs, as well as networks such as the Zanzibar Climatic Change Alliance. Initiatives have focused on fundamental and cross-cutting aspects, including building the governance system for adaptation, through the Africa Adaptation Programme in Tanzania, and on strengthening climate services in the country. The 2012–2017 Adaptation Fund programme will produce an Ecosystem-based Integrated Coastal Area Management Plan, which will be an important innovation for sustainable and institutionalised adaptation in the country.

Section 4.5 focuses in more deeply on the areas of research, teaching, policy engagement and community outreach of HEIs in Tanzania, towards understanding the current status of HEI responses to climate change.

4.5 Existing status of CCD research, education, outreach and networking in Tanzania

4.5.1 Understandings of CCD: National policy, stakeholders and university staff

Tanzania's 2012 National Climate Change Strategy (NCCS) indicates some agreement with the concept of CCD. While the strategy emphasises adaptation as the highest priority for the country, given the country's LDC status and negligible GHG emissions, it also establishes a case for achieving sustainable national development while participating in mitigation initiatives, such as the Clean Development Mechanism (CDM), Nationally Appropriate Mitigation Actions (NAMAs), REDD+, and other carbon markets or trading activities. Further developing a common understanding of the core issues of CCD necessary for knowledge co-production in Tanzania could assist with expanding the conceptualisation in the NCCS, and with formulating concrete initiatives as part of the implementation of the strategy.

Discussions on the concept of CCD in the workshop largely echoed the thrust of the NCCS, highlighting the possibility and indeed desirability of approaching mitigation within a developmental focus that ensures pro-poor benefits and prevents maladaptation. This was particularly discussed in the context of REDD+, which emphasised the need for an integrated approach to adaptation and mitigation, to ensure that mitigation interventions like the REDD programme do not impact negatively on access rights and livelihoods of people, and result in maladaptation.

Workshop discussions focused further on exploring aspects that do not appear to be clearly highlighted in the concept of CCD, which would be decisive in the effectiveness and equity of adaptation and mitigation approaches, such as underlying power relations in development and CC initiatives. Finally, while workshop participants felt that CCD was relevant for Tanzania, some felt that this is simply a re-framing of what is already being done, to some extent.

Amongst the stakeholders involved in CCD-related policy and knowledge mediation activities, different understandings of CCD exist, as shown by these extracts from the questionnaire data:

- Climate change and responses to it are changing patterns of innovation, trade, production and population distribution.
- It's the totality **interactive process** of adaptation and mitigation in climate change.
- Development processes that take into consideration threats and opportunities posed by changing climate i.e. ensuring development goals are safeguarded from climate impacts.
- CCD is the action of emphasising climate strategies that embrace development goals and development strategies that integrate the threats and opportunities of a changing climate. As a result, it heralds a new generation of development processes that safeguard development from climate impacts (climate resilient development) and reduce or keep emissions low without compromising development goals (low emissions development), going beyond the traditional separation of adaptation, mitigation and development strategies. Climate compatible development goes one step further by asking policy makers to consider 'triple win' strategies that result in low emissions, build resilience and promote development simultaneously.
- Reconciling development processes and interventions with strategies for addressing climate change challenges.
- CCD mainly recognises and addresses impacts/ issues related to climate variability and change.
- CCD is the development attained by human beings from activities, which produce no carbon in the atmosphere i.e. carbon free activities which include use of renewable energy, e.g. use of solar energy.
- Climate compatible development could mean the kind of development that considers climate adaptation and mitigation measures for sustainable development.
- CCD is low carbon, climate resilient development.
- In my context 'climate change development' is the realisation of the impact of climate change effects caused by human beings so called development and facing the situation using present resources.
- It is the process of development and mitigation the harms caused by climate impacts and resilience on the areas concerned.
- It's the development that does not harm the environmental condition.
- Initiatives to use low carbon techniques in order to reduce effects of climate change.
- Development that addresses challenges facing the rich and the poor in terms of efficient use and access of resources, technology, knowledge so as to reduce the rate of climate change and its impact and vulnerability.
- In my context due to lack of understanding of ethical issues on climate change for enabling pro-poor awareness amongst decision makers to address vulnerability, limits the focus on pro-poor needs on climate change adaptation.
- 1. Access to reliable and sustainable energy; 2. Forestry protection; 3. Urban environment; 4. Agriculture productivity; 5. Sustainable tourism etc.

Within the universities across Tanzania, there were somewhat different understandings of CCD, as shown by these extracts from the questionnaire data obtained from nine university respondents:

- All developmental activities which are in harmony with nature. They provide current needs without jeopardising nature's productivity for the future.

- To have good breathing air, free from carbon produced from smoke in line with green surrounding areas, cold areas, good scenery.
- Any development that will be sensitive to CC, that will reduce CC impacts and make human life possible.
- Climate change compatible development is development planning and management that mainstream current climate change situations and future scenarios.
- It is about calling for the need to reduce emissions, thus reduce the magnitude of climate change impacts in our region, the global at large.
- This is a sustainable way of using the naturally given climatic opportunities, using the natural endorsement beneficiary but without destroying.
- It is low carbon, climate resilient development.
- Reduce carbon by preventing deforestation, grow more trees and reduce forest fires.
- Climate compatible development is the development that aims in minimising the harm caused by climate change impacts while maximising human development opportunities presented by emission.
- Dealing with adaptation for climate change, a sustainable development.
- In my context it refers to addressing environmental sustainability through the integration of the principles of sustainable development into national policies and programmes and activities that reserve loss of environmental resources.
- Sustainable development / development plans which focus and consider environmental issues.
- These are strategic developments/ mitigation that eliminate resiliency.

From this it is possible to see that although understandings of CCD differ amongst and between stakeholders and university staff involved in CCD related work, there is generally a close conceptual association between climate compatible development and **sustainable development**, and, to a lesser extent, between climate compatible development and **adaptation and mitigation**. It is also apparent that **the concept of CCD is relatively new** to some of the stakeholders. **Context** also has an influence on how CCD is understood, and influences meaning making and understanding of the concept. This has important implications for knowledge co-production processes, and will require careful engagement in development of mutual understanding in such processes.

4.5.2 Current research related to climate compatible development

4.5.2.1 General view

An assessment of what research is needed for CCD in Tanzania and a detailed database search of all research published on climate change / sustainable development research in Tanzania would provide substantive detail on what research is already being conducted in Tanzania. As this fell outside of the scope of this study, it is only possible to show some of the research that is currently being undertaken on climate change in Tanzania.

While the development of national level documents and strategies such as the Initial National Communication to the UNFCCC, the 2007 NAPA and the 20102 National Climate Change Strategy (NCCS) furthered the collection of information and climate data, towards overcoming the limited database on climate observations, projections and impacts, currently climate

change research is not coordinated by a central body. The NCCS has identified the need to harmonise ongoing and future initiatives on climate change, and the Tanzania Commission for Science and Technology (COSTECH) is currently in the process of building a National Research Registry – this is in broad terms, and no reference is made to a national research registry on climate change. The mapping study findings constitute an initial step in drawing together research and active researchers on climate change, as well as nodes and centres of expertise, which can be further built on by relevant institutions such as COSTECH, perhaps driven by the Vice President's Office, towards developing a coherent database for research and initiatives on climate change in the country.

A rapid review of published research on Google Scholar (first ten articles listed with 'climate change Tanzania' in the search) shows the following research on climate change in Tanzania.

Table 7: First ten articles listed with 'Climate Change' and 'Tanzania' in the search and origin of the first author

Article	Origin of first author
Farmer, W., J. Thurlow, K. Strzepek and C. Arndt. 2012. "Climate Change, Agriculture and Food Security in Tanzania," *Review of Development Economics* 16(3): 378-393.	Denmark
Ahmed, S.A., N.S. Diffenbaugh, T.W. Hertel and W.J. Martin. 2012. "Agriculture and trade opportunities for Tanzania: past volatility and future climate change," *Review of Development Economics* 16(3): 429-447.	USA
Tacoli, C. 2011. "Not only climate change: mobility, vulnerability and socio-economic transformations in environmentally fragile areas in Bolivia, Senegal and Tanzania" (Vol. 28). IIED.	Argentina
Ahmed, S.A., T.W.Hertel and W.J. Martin. 2011. "Agriculture and trade opportunities for Tanzania: past volatility and future climate change" (No. UNU-WIDER Research Paper WP2011/91).	USA
Wangui, E.E., T.A. Smucker, B. Wisner, E. Lovell, A. Mascarenhas, M. Solomon,... and P. Munishi. 2012. "Integrated development, risk management and community-based climate change adaptation in a mountain-plains system in Northern Tanzania," *Revue de géographie alpine/Journal of Alpine Research* (100-1).	USA
Fisher, B., S.L. Lewis, N.D. Burgess, R.E. Malimbwi, P. K. Munishi, R.D. Swetnam, ... and A. Balmford. 2011. "Implementation and opportunity costs of reducing deforestation and forest degradation in Tanzania," *Nature Climate Change* 1(3): 161–164.	USA
Thornton, N., C. Cameron, P. Grant, G. Norrington-Davies and J. Zingel. 2011. *Realising the Potential: Making the Most of Climate Change Finance in Africa. A synthesis report from six country studies: Cameroon, Ghana, Kenya, Morocco, South Africa and Tanzania*. London: Agulhas.	UK
Tumbo, S.D., E. Mpeta, M. Tadross, F.C. Kahimba, B.P. Mbillinyi and H.F. Mahoo. 2010. "Application of self-organizing maps technique in downscaling GCMs climate change projections for Same, Tanzania," *Physics and Chemistry of the Earth, Parts A/B/C* 35(13): 608–617.	Tanzania
Cinner, J.E., T.R. McClanahan, N.A.J. Graham, T.M. Daw, J. Maina, S.M. Stead, ... and Ö. Bodin. 2012. "Vulnerability of coastal communities to key impacts of climate change on coral reef fisheries," *Global Environmental Change* 22(1): 12–20.	Australia
Parham, P.E. and E. Michael. 2010. "Modeling the effects of weather and climate change on malaria transmission," *Environmental Health Perspectives* 118(5): 620.	UK

It is encouraging to see that there are a variety of different research publications available regarding Climate Change in Tanzania. Even more encouraging is to see eight out of the first 10 publications with the title including "climate change" and "Tanzania" published within the last two years. Despite this promising finding only one publication in the Google Scholar search was primarily authored by a researcher from Tanzania. This appears to show little to no research presence of Tanzanian researchers in the international arena of published climate change research, despite the growing climate change policy environment. However, it is also likely to be an artifact to some extent of the popularity of conducting research on climate change in Tanzania on the part of international researchers. Using a different search engine or search parameters would of course have generated a different set of publications, undoubtedly showing additional Tanzanian authors.[15]

For example, the search does not indicate a paper published by the active researcher P.K.T. Munishi at Sokoine University of Agriculture published in 2010 in the Journal of Environmental Management, entitled 'Mapping socio-economic scenarios of land cover change: A GIS method to enable ecosystem service modelling', which focuses on modelling the potential for carbon storage in the Eastern Arc Mountains of Tanzania using two scenarios. Note, however, that P.K.T. Munishi is an author on two of the articles listed in the Google Scholar search.

The articles/chapters identified through the search focus on vulnerability, impacts and adaptation, in the fields of health, fisheries, agriculture and food security; and also include research on agriculture and trade in Tanzania in the context of climate change, climate finance, and implementation of REDD+, within an integrated development and integrated adaptation-mitigation approach.

4.5.2.2 University-based research

The Tanzania questionnaire and workshop data shows a diversity of university faculty and department involvement in climate change related research, as indicated in Table 8.

Table 8: Diversity of university faculty and department involvement in climate change research

Faculty / School / Centre	Department	Programmes / Institutes
UNIVERSITY OF DAR ES SALAAM College of Education (DUCE); Humanities and Social Sciences	Geography	The East Africa Savannah Ecosystem Research Programme. East African Savannah Ecosystem under climate change. A collaboration with the Michigan State University USA
MKWAWA UNIVERSITY COLLEGE OF EDUCATION; Humanities and Social Sciences	Geography	Impact of CC to food production. Traditional environmental knowledge system in climate change coping and adaptation

[15] In the interests of consistency across all 12 countries included in the mapping study, the same Google Scholar search was conducted and included in the respective country reports.

Faculty / School / Centre	Department	Programmes / Institutes
UNIVERSITY OF DODOMA; Informatics	Information Systems	ICT and adaptation to climate change: innovative and integrated solutions to address challenges of water resources in the Lake Victoria basin
SOKOINE UNIVERSITY OF AGRICULTURE (SUA)	Agriculture	Centre for ecosystem analysis and climate change
UNIVERSITY OF DAR ES SALAAM, Institute of Resource Assessment (IRA)	Institute of Resource Assessment	Wider experience on CCD related research projects; housing Centre for Climate Change; Masters Programme; Secretariat for REDD

Note: Table is likely to not be complete, and is therefore indicative rather than definitive.

Table 8 above shows both faculty-based diversity and departmental level diversity of participation in climate change related research and teaching research University of Dar es Salaam, Mkwawa University College of Education, University of Dodoma and Sokoine University of Agriculture. The table also shows that between the universities most of these have some form of climate change related research programme. It is curious however that little of this work is showing up as recent publications in the international arena; it may be necessary to investigate what is inhibiting the publication of this research.

Workshop and questionnaire data indicated research taking place on topics related to CCD, as set out in Table 9.

Table 9: Research projects currently being undertaken in response to CC and the need for CCD

Institution, Faculty, Department	Research project	Researcher/ or Deans / HODs	Type of research project
UNIVERSITY OF DAR ES SALAAM COLLEGE OF EDUCATION (DUCE), Humanities and Social Sciences, Geography	Impact of climate change on ecosystem function	Dominique Andrew Lukiko mydlukiko@yahoo.co.uk	▪ Study on the impact of Climate change on the East Africa Savannah Ecosystem
UNIVERSITY OF DAR ES SALAAM, Institute of Resource Assessment	Baseline studies and sector-based analysis of climate change impacts and responses; houses Centre for Climate Change		

Institution, Faculty, Department	Research project	Researcher/ or Deans / HODs	Type of research project
SOKOINE UNIVERSITY OF AGRICULTURE, Department of Forest Biology and other departments	Ecosystem analysis and climate change	P.K.T. Munishi	▪ Climate Change Impacts Adaptation and Mitigation (CCIAM) on various aspects related to REDD+ ▪ Enhancing pro poor innovations in natural resources & agriculture value chain-EPINAV ▪ Local Knowledge Climate Change Adaptation Programme-LKCCAP
MKWAWA UNIVERSITY COLLEGE OF EDUCATION, Humanities and Social Sciences, Geography	Impact of CC on food production	Evaristo Haulle haulledict@gmail.com	▪ Traditional environmental knowledge system in climate change coping and adaptation
UNIVERSITY OF DODOMA, Informatics, Information Systems	ICT and adaptation to climate change	Hector Mongi hjmongi@yahoo.com	▪ Innovative and integrated solutions to address challenges of water resources in the Lake Victoria basin
DAR ES SALAAM UNIVERSITY COLLEGE OF EDUCATION, Faculty of Education, Curriculum and Teaching	ESD in higher education	Leatitia Gabriel Mashaza leatitiagabriel@yahoo.co.uk	▪ ESD change project on development Education which aims at developing a course on development education

Note: Table is based on a limited number of questionnaires and therefore does not reflect the full scope of research projects and programmes relevant to CCD in Tanzania, and is therefore indicative rather than definitive

Table 9 shows a range of research projects and programmes related to CCD. The mapping study data, which is highly likely to be incomplete, given the constraints of the study and limited questionnaire responses, indicates research activities across the fields of impacts of climate change on food security and ecosystem services, as well as education for sustainable development (ESD). An innovative project concerns the use of ICT to address challenges of water resources in the Lake Victoria basin, carried out by the University of Dodoma Informatics and Information Systems sections, indicating non-traditional disciplinary engagement in the CCD area.

Curiously, the workshop and questionnaire responses did not highlight the range of significant relevant research being carried out under the Climate Change Impacts, Adaptation and

Mitigation programme (CCIAM) programme, a collaborative research programme between SUA, UDSM, Ardhi University and the Tanzania Meteorological Agency (TMA), and the Norwegian University of Life Sciences through its Department of International Environment and Development Studies (Noragric).[16] Through research projects, capacity building, documentation, awareness raising and outreach, CCIAM will focus on enhancing a greener environment by promoting natural forest conservation, afforestation, reforestation and better agricultural practices for improved livelihoods related to the Reducing Emissions from Deforestation's and Forest Degradation (REDD) initiative. Internet research carried out subsequent to the Tanzanian workshop reveals 26 different research projects being carried out under this programme, which runs from 2009 to 2014. This significant collaborative research programme involves a range of different disciplines and project types across the three Tanzanian universities and the TMA. To provide specifics on just three of these projects, research ranges from quantification, modelling and mapping carbon stocks and plant diversity in different land cover types in Tanzania (led by SUA), includes the role of local government in implementing REDD (led by UDSM); as well as analysis of the impacts of urban land use and climate change on coastal forest ecosystem and management (IULUCC-CFM) (led by ARU). A further project focuses on the role of indigenous knowledge in community adaptation and mitigation response to the impacts of climate change in Tanzania (led by TMA). A clear focus across a number of the 26 research projects is the impact of REDD+ on livelihood security.[17]

Several policy documents reviewed appeared to have made good use of papers or reports written by Tanzanian academics. For example, the NCCS drew on the following peer-reviewed articles and books:

- Elisa, M., J.I. Gara and E. Wolanski. 2011. "A Review of Water Crisis in Tanzania's protected areas with emphasis on Katuma River-Lake Rukwa Ecosystem," *Journal of Ecohydrology & Hydrobiology* [DOI: 10.2478/v10104-011-0001-z].
- Tonnang, H.E.Z., R.Y.M. Kangalawe and P.Z. Yanda. 2010. "Predicting and mapping malaria under climate change scenarios: The potential redistribution of malaria vectors in Africa," *Malaria Journal* 2010 9: 111 [DOI: 10.1186/1475-2875-9-111].
- Kangalawe, R.Y.M., C.G. Mung'ong'o and P.Z. Yanda (Eds.). *People's Perceptions and Community Response to Climate Change and Variability: Selected Cases from Tanzania.* Institute of Resource Assessment, University of Dar es Salaam.
- Yanda, P.Z., R.Y.M. Kangalawe and R.J. Sigalla, 2006. "Climatic and socioeconomic influences on malaria and cholera risks in the Lake Victoria Region of Tanzania," *ICIFAI Journal of Environmental Economics* (IJEE) 4 (3): 44-70.

[16] See http://www.suanet.ac.tz/cciam/index.php/about-cciam, accessed 5 December 2013.
[17] The full list of 26 projects is available from a link on this page: http://www.umb.no/noragric/article/climate-change-impacts-adaptation-and-mitigation-cciam-programme-in-tanzania/

The NCCS also drew on the following consultancy reports written by Tanzanians:

- Kangalawe, R.Y.M. 2010. "Mainstreaming climate change adaptation in the management of freshwater resources in the Rufi ji Basin". A consultancy report submitted to the Ruaha Water Programme. WWF-Tanzania Country Office, Dar es Salaam.
- Meyer, B., J.J. Balozi, M.W. Shanyang, N.A. Mwangulango and A. Qolli. 2006. "Katavi Rukwa Ecosystem". Report KRCD project, GTZ/ECO-AGEG.

These articles and reports show a predominance of research on health-related aspects, as well as water issues; a number of the papers include the very active and distinguished researcher, Professor P.Z. Yanda.

Associated with the research programmes and other smaller scale research initiatives mentioned above are a number of active researchers. See Appendix B for a list of the researchers identified in workshop and questionnaire data. The list is clearly incomplete, but does indicate a range of active researchers working across the physical and social sciences, with good emphasis on the developmental and livelihoods aspects of climate change, and some innovative research on use of ICT in studying climate change.

Gender and PhD profile: Of those lecturers responding to the questionnaire two were female, showing some participation of women scientists in climate related questions in Tanzania. Most of those responding to the questionnaire had four or more years experience in their disciplines. While none of the questionnaire respondents engaged in climate change and CCD related research had a PhD, this was due to limited response to the questionnaires. Further follow-up by the mapping study team has added five senior active researchers with PhDs, a number of whom are extensively published and internationally known, such as Professor Pius Yanda of UDSM, who now heads up the Centre for Climate Change housed within the Institute of Resource Assessment, and Professor P.K.T. Munishi, of the Sokoine University of Agriculture, whose publications have been noted above. While it is positive that several of the active researchers on climate change have PhDs and head up relevant centres, there is still a need, as is the case for the whole of the southern African region, for improved institutional and academic support for developing more PhD scholars in climate change and CCD-related fields.

4.5.2.3 Centres of Expertise and Networks[18]

Some centres of expertise in climate compatible research in Tanzania were identified from the questionnaires as being:

- Lake Victoria Research Initiative;
- Tanzania Natural Resource Forum;
- Forum CC Tanzania;
- Institute of Resource Assessment of the University of Dar es Salaam-Baseline studies and Sector-based analysis of climate change impacts and responses;
- APCCC is a specialist Non Governmental Organisation with experts in several fields, some of whom are on the IPCC; and
- Centre For Climate Change Studies-CCCS at University of Dar es Salaam.

Tanzania Research Networks cited include:

- Climate Change Impacts Adaptation and Mitigation-CCIAM done by Sokoine University of Agriculture;
- Enhancing pro-poor innovations in natural resources and agriculture value chain-EPINAV done by Sokoine University of Agriculture;
- Local Knowledge Climate Change Adaptation Programme (LKCCAP) of Sokoine University of Agriculture;
- National Climate Change Technical and Steering Committee;
- Lawyers Environmental Action Team (LEAT);
- Tanzania Meteorological Agency (TMA); and
- Reducing Emissions from Forest Deforestation and Forest Degradation-REDD+.

Regional Environmental Research Centres relevant for knowledge co-production on climate change and CCD in Tanzania that were identified include:

- SADC REEP: Southern Africa Development Community Regional Environmental Education Programme;
- SADC Drought Monitoring Centre;
- SADC Meteorological Services; and
- SARUA.

4.5.3 Curriculum innovations and teaching for CCD

Questionnaire responses indicate that all the participants from the various universities showed a willingness to get involved in new issues such as climate change and/or climate compatible development with regard to their curriculum innovation and teaching, and the questionnaire

[18] Centres of Expertise refers to already established research centres or institutes most often operating at university level, or between a number of universities with networked partnership links (these may be national or international). A research network refers to interest-based research groupings that convene regularly to discuss or debate research or concerns that are relevant to CCD.

data showed that staff ability to get involved was good. University of Dar es Salaam College of Education (DUCE), showed the greatest incidence of CCD issues and opportunities incorporated into their current curriculum. University of Dodoma showed some experience with regard to multidisciplinary teaching approaches to CCD. All the universities had some courses that clearly focus on development of social and/or technical innovation and ethical actions.

Curriculum development, providing short courses to CC teachers, and other education needs were given high priority both in the workshop and the questionnaires. A great deal of discussion arose around this in the workshop. As one participant highlighted:

> *"It is easy to produce a guide for teaching, but whatever you produce has to be in the syllabus, so you have to have it in the syllabus, and in a localised way, so it has to be for Tanzania, not for China. I would go for short courses for teachers, so they know what to teach, and I would go for including this in the syllabus."*

Some participants wanted the incorporation of informal education, while others emphasised issues of awareness raising, arguing that universities should see how they can engage communities in raising awareness. One participant noted that while there were many institutions engaged in CCD, the first issue to consider was, exactly what should be taught?

The following specific courses were identified as being on offer (cited in the workshop discussions and questionnaire data). As climate change is often infused into existing courses, it is not easy to 'detect' climate change content in existing course descriptions, unless the courses are specifically 'named' as climate change courses. Thus it is not simply a matter of reviewing all the courses in an institution; rather, identification of climate change content in courses would thus require engaging with those that teach the courses. Data presented is therefore limited by this factor.

Table 10: Courses oriented towards climate compatible development – based on questionnaire and workshop data only

Course/s being developed and run	Who is involved	Type and level of course
University of Dar Es Salaam College of Education (DUCE): ▪ Introduction to climatology 1st year ▪ Natural Resources Management 3rd year on their 1st degree	Dominique Andrew Lukiko	Undergraduate
Mkwawa University College of Education, Geography: ▪ Environmental Education (1st year), Climatology (1st year)	Helena E Myeya	Undergraduate
University of Iringa: ▪ 3-8 courses in Geography, Tourism, community development ▪ Development studies as well as education courses	Dr Gilmans Nyamubi	Undergraduate
Mkwawa University College of Education, Geography: ▪ CT204: Contemporary issues in Science Education: Climate Change, 3rd Year module	Innocent Buberoa Rusambuka	Undergraduate

Course/s being developed and run	Who is involved	Type and level of course
Muhimbili University of Health and Allied Sciences, Environmental and Occupational Health: ▪ Undergraduate – MD2 DDS2 BSc RTT and BMLS – Course Environmental Health and Family case studies – just a topic ▪ MSc EOH – Impact of Climate Change on Health	Larama MB Rongo	Undergraduate and Postgraduate
The Open University of Tanzania, Geography: ▪ Background to physical resources. Climatology. African Environment and Development. Environmental Education	Reguli Mushy	Undergraduate
University of Dar Es Salaam College of Education (DUCE), Geography: ▪ Environmental management	Saumu Jumanne	Undergraduate
Mkwawa University College of Education, Geography: ▪ Environmental resources and food security. Physical geography. Environmental education. Climatology	Ubaya Msemwa	Undergraduate
University of Dar es Salaam (UDSM) ▪ Centre for Climate Studies ▪ Training MSc CC and SD ▪ Conduct short courses on climate change ▪ Seminars and workshops on climate change ▪ Postgraduate courses on climate change ▪ MSc on Natural Resource Management in the Institute for Resource Assessment	Prof Pius Yanda	Postgraduate
Sokoine University of Agriculture (SUA) ▪ MSc. MNRSA Management of natural resources for sustainable agriculture ▪ Masters programme on Ecosystem Sciences and Management – almost half of the courses are related to CC, including gender and CC	Prof. P. Munishi	Postgraduate

Note: This list is not exhaustive, it can be updated and extended.

As can be seen from Table 10, the University of Dar es Salaam (UDSM), Centre for Climate Studies has a dedicated MSc on Climate Change and Sustainable Development, and offers further CC / CCD courses at postgraduate level. Sokoine University of Agriculture's MSc MNRSA – Management of natural resources for sustainable agriculture – is a further innovation highly relevant for climate change, and for an integrated adaptation-mitigation approach. Beyond this, the dominant pattern of practice appears to be to 'integrate' aspects of CCD into existing courses, with the majority of course being offered mainly in Geography. The Muhimbili University of Health and Allied Sciences' Masters in Environmental and Occupational Health (MSc EOH) includes a module on the 'Impact of Climate Change on Health', which is a further positive innovation for the under-researched area of climate change impacts on health. In general, it is difficult to examine the scope and focus of such integration of climate change and CCD into existing courses without a detailed curriculum analysis. The table above also indicates that it may be productive to examine CCD integration within all faculties and all departments within the university. The university-based questionnaire (especially Section C) in Appendix C can be used for this purpose. The questionnaire would, however, need to be introduced to all

staff in the university, preferably at Departmental level to obtain a clearer view of how CCD is / is not being integrated into teaching, and where the 'gaps' are for new development of CCD content into either existing programmes or the design of new programmes. Such a process would need to be led by the Academic Registrar of the university to ensure consistent and comprehensive data.

Apart from training on the part of the universities and colleges, the Institute for Environment, Climate and Development offers a number of specialised short courses, such as on carbon trading, climate change and food security, and monitoring and evaluation of climate change adaptation programmes. The institute can also develop tailored courses, and offers certificate and diploma courses on environmental science and management. In the future, it was noted that the institute could be developed to offer degree programmes.

Teaching methods that were identified in the questionnaire as being potentially effective for CCD in courses beyond traditional processes included:

- Traditional lecturing of theories and the use of case studies as examples for the spatial and temporal analysis of climate change related aspects;
- Field visits – this is usually done through teacher/student engagement;
- Excursion/ field work on CCD;
- Case studies and project development;
- Interactive participation;
- Powerpoint presentations and lecturing on the available data on climate change issues (impacts, adaptations and mitigations).
- Group discussions based on experiences on climate change issues and sustainable development;
- "I would rather use project oriented approach in which students will be given a bit of theories but much of the time they will be required to engage in a project of their choice to show vividly how they can remedy the climate destructed area"
- Theoretical (lecturer), practical field work – planting trees, visiting water sockets, forests;
- Problem solving method and project method;
- Participatory methods; and
- Open and distance learning.

The list of teaching methods shows a good focus on practical, field work, participatory and problem solving approaches, relevant for the solution-oriented concept of CCD.

Inter- and transdisciplinary approaches to curriculum innovation are discussed in section 5.

4.5.4 Community and policy outreach

As noted above, several policy documents reviewed appeared to have made good use of papers or reports written by Tanzanian academics, including the National Climate Change Strategy. In general workshop discussions indicated that enhanced attention was required to policy outreach, noted the gaps between research and policy, and mentioned engaging with the political dimensions of the problem, as politicians would ask themselves how many votes they may lose or gain by taking this agenda forward.

> *"It has been nearly nine years since the Environmental Management law was passed, and we don't see anything happening. These policies need to be revised and updated to take into account climate change issues."*
>
> Tanzania university lecturer

Discussions in the workshop highlighted the need for an effective research – policy interface, which participants noted is critical for science-based and evidence-based decision making. Workshop participants noted the need to really focus research on the needs of poor and vulnerable communities, as expressed in the following quotations.

> *"We see more research on climate change, vulnerability and adaptation. But there are other issues that need to be focused on, such as power balance issues. Are we as researchers focusing on the right issues that will really help the poor people?"*
>
> Tanzania university staff member

> *"Everyone is talking about REDD, planting trees etc, but most of these areas are pastoral areas, most of them are poor land with marginal farmers, what happens to them when we turn all of these areas into REDD forests?"*
>
> Tanzania university staff member

Questionnaire data showed some specific examples of university staff contributing to sustainable outreach, such as the University of Dodoma who encouraged paperless presentations and communications and Dar Es Salaam University College of Education who are involved in planting trees, gardening and economical use of electricity and water. No specific policy engagement processes were mentioned in the questionnaire.

4.5.5 Student involvement

The questionnaire data cited the following student organisations that were involved in climate change and CCD related activities:

- TUTSA, CAG at the University of Iringa;
- Students Club: Dar-Es-Salaam University College of Education, the Department of Geography hosts the UN-CHAPTER. Students Club for climate and climate change. Head of Department: Dominick Lukiko; and
- University of Dodoma: Student Green Journey Climate Change.

No further information was provided on student involvement in climate change and CCD.

4.5.6 University collaboration and networking

4.5.6.1 Potential knowledge co-production partners

Based on the priorities and gaps identified, and the range of skills and expertise present amongst Tanzanian HEIs and other stakeholders, the institutional analysis indicates a high level of *potential* for knowledge co-production partnerships, with some knowledge partners already existing for CCD knowledge co-production in Tanzania. Table 11 shows these 'mapped' out, with ascribed roles (as per workshop discussions).

Table 11: CCD Knowledge co-production partners (potential, with some already actualised)

Research organisations	Civil society organisations	Private Sector	Government	Regional organisations	International organisations
▪ University of Dar es Salaam (UDSM) Centre for Climate Studies Mwalimu Nyerere Professorial Chair for Environment and Climate Change ▪ Institute of Resource Assessment (IRA) ▪ Mkwawa University College of Education (MUCE) ▪ University of Dodomo ▪ Open University of Tanzania (OUT) ▪ Sokoine University of Agriculture (SUA) ▪ Tumaini University of Iringa ▪ Muhimbili University of Health and Allied Sciences (MUHAS)	▪ Forum CC Tanzania ▪ Zanzibar Climatic Change Alliance ▪ OSSREA Tanzania chapter (Organisation for Social Science and Research in East Africa) ▪ Tanzania Natural Resource Forum ▪ Institute for Environment and Sustainable Development		▪ Vice President's Office – Environment ▪ Ministry of Agriculture and Food Security ▪ Ministry of Natural Resources and Tourism ▪ Tanzania Meteorological Agency (TMA)	▪ SADC REEP ▪ East African Community-EAC ▪ Southern African Development Community-SADC ▪ East African Community climate initiative ▪ Strengthening University Contributions to Climate Compatible Development in Southern African – SARUA ▪ United Nations Development Programme-UNDP ▪ Nile Basin initiatives ▪ East African Association for Impact Assessment ▪ WaterNet ▪ SADC early warning system ▪ Victoria Basin Initiatives ▪ Regional Climate Outlook Forum ▪ Sida ▪ UNESCO ▪ African Forest forum-AFF ▪ Eastern African Ecological Society-EAES	▪ UNDP ▪ UNEP ▪ Reduced Emissions from Deforestation and Forest Degradation (REDD+)

It is interesting to note the absence of any private sector organisations suggested as potential knowledge co-production partners, and the limited number of NGOs identified.

Specific priorities were identified for universities' roles in enabling CCD research.

Table 12: Role of the university sector in enabling CCD related research and teaching

Roles ascribed to the university sector for climate change and CCD-related matters	
Training ■ Train more expertise in Climate Change field ■ Training and impacting skills relevant to CCD ■ The role of university in capacity building on CCD to different stakeholders/sectors/students	Research ■ Training on CCD issues ■ Research on CCD ■ Outreach programmes for CCD ■ Research on alternative sources of energy to enhance/improve CCD
Outreach ■ Role of university on CCD ■ User drivers researcher on CCD ■ Technological innovation ■ Train relevant experts	Dissemination of research ■ Catalyst for social change ■ Impart knowledge and skills ■ Research and dissemination and feedback ■ Engaging in action research ■ Designing teaching courses related to CCD ■ Dissemination of research findings to all stakeholders
Sensitising/catalyst for change ■ Teaching ■ Doing research ■ Consultancy ■ Sensitising and enhancing other institutions (Resource user)	Technology development ■ Develop technologies ■ Training for appropriate technologies ■ Harmonisation of existing skills and knowledge to be usable to consumers ■ Monitoring and evaluation of the provided training

Apart from identifying the traditional roles for universities, such as research and teaching, there is strong emphasis on the role of universities in catalysing social change, as well as for technological innovation, and the need for greater emphasis on disseminating research and using this as an opportunity for greater sensitisation of other stakeholders on key societal challenges such as climate change.

Engaging with such knowledge partners in / for knowledge co-production requires capacity for collaboration. The discussion on university collaboration (and data on this from the questionnaires) revealed the following possibilities for enhancing such collaboration (Table 13).

Table 13: Changes needed to create an enabling environment for CCD collaborative research and action

Knowledge partners	What needs to change
UNIVERSITIES	▪ Establish research coordination desk in the department ▪ Conduct workshops to enable collaborative and interdisciplinary research ▪ More funds to facilitate research ▪ Involve local community/users from grassroots ▪ Strengthen action-oriented research/innovations ▪ Training workshops on CCD ▪ Mentor young generation/teaching research ▪ Network among universities/consultancy ▪ Multidisciplinary training ▪ User-driven research ▪ Disseminating research results ▪ Create common understandings among various disciplines ▪ Change researchers' attitude to enhance respect and trust on each other ▪ Develop policy on CCD
DONORS	▪ Do not dictate ToR; rather community should do this ▪ Reduce unnecessary restrictions
PRIVATE SECTOR	▪ Utilise research results ▪ Support research on CCD through co-financing
GOVERNMENT	▪ Finance research ▪ Reduce bureaucracy ▪ Harmonise institutions ▪ Capacity building

In line with sentiments expressed at the workshop, Tanzania's 2010 National Research and Development Policy identifies as a critical issue the inadequate collaboration among researchers from different disciplines/institutions and the private sector so as to optimise the use of resources and increase efficiency, and proposes various mechanisms to overcome this. These could be further discussed in Tanzania, and used to develop a strategy to enable collaborative research. Additional detail on enhancing this kind of research is provided in section 5.

4.5.7 University policy and campus management

Limited information was received on the engagement of university policies and management with climate change and CCD. The University of Iringa noted that it is involved in community-based activities in the area, from tree planting to cleaning and protecting water sources in the surrounding community. The Dar Es Salaam University College of Education is involved in environmental conservation activities, including tree planting activities around the university campus, as well as land enhanced irrigation. They are also involved in waste management monitoring.

4.6 What existing practices can be strengthened and what can be done differently?

4.6.1 A multi-faceted process, needing an integrated approach

Discussions in the workshop on 'who is doing what and how' led to some reflections on the status quo, and what could be done differently. These show that Tanzanian stakeholders, researchers and lecturers have a very clear understanding of what needs to be strengthened and what could be done differently when it comes to CCD in research, teaching, outreach and networking in their contexts. The outcomes of the workshop and questionnaires indicate several different key areas requiring attention, which are not restricted particular research disciplines or institutions, but rather affect various different fields and territories. This shows that responding to the current situation in Tanzania with a view to 'doing things better, requires an integrated approach, and will require especially the participation of university and government leadership, but also leadership of other stakeholders (e.g. business). Specific suggestions are discussed in the rest of section 4.

4.6.2 Co-ordination, collaboration and improved partnership building:

The workshop discussions highlighted the critical and cross-cutting issue of inadequate university resources, which militated against the utilisation of existing capacity, such as infrastructure for teaching programmes. The workshop discussions also highlighted the need for strengthening collaboration between universities and industry in order to meet the needs of the industry. A participant from the Ministry of Natural Resources and Tourism observed that universities are sometimes consulted by some ministries and departments to provide technical support in the form of research, etc., but the universities don't follow-up on whether what they recommend works out in practice. Thus universities could strengthen their action orientation, and perhaps review and improve the ideas and recommendations they have made. Overall, research collaboration was seen to be missing not only among universities, but also across all the stakeholders.

It was further pointed out that the Tanzania Meteorological Agency (TMA) has two departments dealing with climate change, with more than six PhDs, more than 30 people with Masters degrees, and many more with other qualifications. The TMA thus represents significant human resources capacity, and universities should take the opportunity of using the TMA and its resources. This will include dynamical downscaling, which will be initiated in December 2013 for a specific climate change project.

> *"The TMA is producing public goods, and if we have collaboration with the universities, that will be good. If the situation is going on like this, you are not going to have competitive students coming out of the university, because of the problems you are having, like with infrastructure."*
>
> Tanzania government stakeholder

The Centre for Climate Change and Sustainable Development and the Institute for Resource Assessment (IRA) at UDSM were noted as key centres for CC research and potential collaboration and co-ordination efforts. The IRA hosts the CC Centre and is the Secretariat on REDD+.

4.6.3 Strengthen and expand understandings of CCD

As shown in section 4, CCD is a relatively new concept to some stakeholders and university researchers, while it is a concept well understood by many of the experienced researchers across different institutions. Elements of responding to climate change that are consistent with CCD are being integrated into the research and teaching of a range of university staff. From the workshop and questionnaire data it can be seen that the concept of CCD does lend itself to a diversity of contextual interpretations. It is also multi-disciplinary, and multi-facetted and has diverse research and capacity building implications. This was further explored in the workshop which brought in regional perspectives, stressing that there is need for alternative development options that are continually responsive to climate change and emerging global and regional development paradigms related to climate, which take into account what is happening in the region in and around Tanzania. The suggestions provided by participants in the mapping study on how to strengthen the coverage of climate change in their research, teaching, community and policy outreach, as indicated throughout this report, provide opportunities as well for strengthening awareness on climate change more broadly; it will be up to Tanzanian stakeholders and university staff to decide whether this should be done under the umbrella of the CCD concept or not.

4.6.4 Capacity building for CCD and staffing

The mapping study has identified a strong call for capacity building, particularly for undertaking climate change-related research, but also for integrating CCD into curriculum and teaching. As this is a multidisciplinary issue, such capacity building should take both a specialist (to develop specialist research capacity) and a multidisciplinary approach that allows for knowledge exchange and the development of collaboration. While there are examples of multidisciplinary research and capacity development, it will be critical to further enable these capacities in Tanzania. The regional knowledge co-production framework being developed as a key outcome of this SARUA mapping study will provide concrete suggestions for a regional approach to capacity development, to strengthen university contributions to responding to climate change.

4.6.5 Curriculum development and curriculum innovation

As shown in the institutional analysis above, with the exception of the UDSM's Master programme in Climate Change and Sustainable Development, CCD is currently mainly being 'integrated' into existing courses. Some courses include climate change issues to a very high degree, such as the Masters programme on Ecosystem Sciences and Management at Sokoine University of Agriculture, in which almost half of the courses are related to climate change, including gender and climate change.

At the undergraduate level, climate change curriculum development focuses mainly on introductory courses, dominated by undergraduate Geography courses. An interesting and potentially valuable contributor to future CCD-related curriculum development was the undergraduate course offered by Muhimbili University of Health and Allied Sciences within the Environmental and Occupational Health discipline, as well as the MSc which includes a module on the impact of Climate Change on Health.

It was also stressed that a significant research gap exists regarding a curriculum assessment, which should include mainstreaming important climate change issues into the curriculum, and deciding which issues are important to be mainstreamed at which levels – primary, secondary and tertiary levels.

Sokoine University of Agriculture noted that they revise their curriculum every five years, and that climate change is an emerging issue which is being continuously better integrated. SUA is thinking of developing another programme on Climate Change and Natural Resources, and encourages students to focus on climate change and other emerging issues in their final-year research.

> *"The question of CCD is something that is coming in very strongly, like ecosystem-based adaptation, and we need to include this because we are talking about the future."*
>
> Tanzania university staff member

Dar es Salaam University College of Education has a team trying to develop a course on developmental education, in which environmental issues, and presumably climate change, will be a big component.

A critical constraint affecting all HEIs, as identified by workshop participants, was the aspect of resources, such as equipment and infrastructure. As one participant noted, "In past few years, the number of students has doubled in one course, and infrastructure has remained the same." Thus the HEIs are experiencing a big problem with the practical side of things, which mitigates against them innovating and delivering the quality of courses they would like to. As another participant stated, "we want people to produce more, without adding any resources."

The workshop discussions called for collaboration, not only in a workshop like the SARUA one, but in developing a teaching programme, and noted the need for standardising courses across the universities, in order to produce experts that have relevant qualifications. The question of harmonisation of courses raised the need for a coordinating body at the national level. A counter view expressed, however, was that universities needed to compete in meeting the industry or community's needs, and that having a uniform syllabus would be devastating, because diversity and competition is necessary. It was further noted that more training was needed on the physical sciences and the technical side of climate change, that is, on climatology and meteorology.

> *"The point of harmonisation among universities came out very clearly in our discussions. If you assume that climate change is part and parcel of environmental management, you could see a very big problem. Because the universities have very different backgrounds. For example, UDSM approaches this from the geography side while SUA is from the forestry perspective. So it is very possible that we may not teach environmental management as such, but we may more teach from our disciplines. I went to Makerere, when I did my Masters programme on NRM, I found most of the emphasis on agroforestry, rather than broader NRM."*
>
> Tanzania university lecturer

4.6.6 Research

Key amongst research aims highlighted in the workshop and questionnaire data was the need to extend research into the development of climate change and CCD related curricula, as well as research into new forms of pedagogy that can enable the implementation of such curricula. Specific research needs focused on biodiversity, agriculture, food security, modelling, and water resource management. Overall there was a call to harmonise and consolidate research efforts on climate change in Tanzania, which seem to largely focus on the impact of climate change on ecosystems, the role of traditional environmental knowledge in enabling coping and adaption to climate change, research on a range of issues related to the implementation of the REDD+ programme, innovative responses to address water resource challenges, sustainable agriculture, and research into education for sustainable development.

A number of research programmes implemented in Tanzania to date have played an important role in enabling collaboration amongst researchers, although apparently not in an interdisciplinary fashion. One good example is the Climate Change Impacts, Adaptation and Mitigation programme (CCIAM) in Tanzania, mentioned previously. Through research projects, capacity building, documentation, awareness raising and outreach, CCIAM focuses on enhancing a greener environment by promoting natural forest conservation, afforestation, reforestation and better agricultural practices for improved livelihoods related to the "Reduced Emissions from Deforestation's and Forest Degradation (REDD)" initiative. Fifty Masters and 16 PhD Tanzanian students, and 27 young and senior professionals in an exchange programme will be involved in the Programme during the course of the five-year period.

Many recommendations were made on how research for CCD could be improved in Tanzania's university and between other stakeholders. These included establishing CCD research coordination systems in university departments, and offering workshops to enable collaborative and interdisciplinary research. Funding is needed to support such research efforts, and facilitate research that involves local community/users from grassroots. Strengthening action-oriented research and research innovations were also suggested, as was the need to enable younger generations to participate in such research and potential teaching through mentoring systems and workshops. Tanzania was seen to be desperately in need of a central network in which universities, consultancies, NGOs, and governments could participate in knowledge transfer and collaboration, as well as create opportunities for multidisciplinary research and training. Finally it was agreed that more supportive climate change/CCD policy is needed to enable research efforts in this direction.

> *"We are working outside the university, so let's say we don't have capacity to do some research that we need, so we come and beg to the universities for help. But the problem is that universities produce very good documents, but they don't follow up with us on how that is implemented."*
>
> Tanzania stakeholder

In 2013, the National Institute for Medical Research developed Tanzania National Health Research Priorities for the period 2013 – 2018. This provides a possible model for what could be done in the field of climate change, building on the initial findings of this mapping study. Tanzania's 2010 National Research and Development Policy provides strong support for the overall objectives of the SARUA five-year programme, stating in its opening sentence that "The contribution of research in development cannot be over emphasised."

In addition to the HEIs, the following research institutes, amongst others, could be involved in further developing Tanzania's national research agenda on climate change:

- Tanzania Coffee Research Institute (TaCRI);
- Tanzania Fisheries Research Institute (TAFIRI;)
- Tanzania Forestry Research Institute (TAFORI);
- Tanzania Technology Development Organisation (TaTEDO);
- Tanzania Wildlife Research Institute (TAWIRI);
- Tanzania Gender Network Programme (TGNP); and
- Tea Research Institute of Tanzania (TRIT).

Tanzania also has a number of private research organisations, largely focused on the social sciences, which could be brought into a process to develop a national research agenda on climate change. They include:

- Economic and Social Research Foundation (ESRF);
- Research for Poverty Alleviation (REPOA);
- Society for Women and Aids in Africa -Tanzania (SWAAT); and
- Private universities.

4.6.7 The role of university leaders

Several questionnaire respondents felt that university leaders play a very influential role in supporting CCD research and development in universities. While one of the highly prioritised research gaps mentioned was the need to improve and expand curricula to incorporate climate change and CCD-related material, respondents felt that university leaders and managers played a significant role in enabling such expansion. A respondent felt that the decentralisation of power was an important step that needs to be taken to involve more stakeholders such as staff and students in planning and developing programs related CCD. Leaders were also seen to be responsible for encouraging community outreach programmes as part of teaching and learning. Fundraising, and resourcing climate change and CCD-related programmes was considered a fundamental responsibility of university leaders as was the need to create university wide policy that encourages climate change and CCD-related research. The formulation of monitoring and evaluation mechanisms was considered a key

responsibility. Sustainable campus management that provides better energy and water use was also cited. University leaders were also considered to be responsible for developing networks and setting research agendas to include climate change and CCD. Finally, overall capacity building across university departments in connection with climate change and CCD was seen to be a responsibility held by university leaders and managers.

Discussions also highlighted the need for greater engagement with politicians as part of the leadership process, as expressed in the following quotation.

> *"The road that is going to be built through the Serengeti National Park, so there are many voices saying that this road should not be built. But the politicians have very different ideas, and recently I have heard that this is going to happen. So there is this challenge … is it possible for these people from the universities to push the politicians and make sure that something should be done. But do they have that power?"*
>
> Tanzania stakeholder

5 KNOWLEDGE CO-PRODUCTION POSSIBILITIES

5.1 Current knowledge co-production practices via multi-, inter- and transdisciplinary approaches

5.1.1 Clarifying the meanings of multi-, inter- and transdisciplinary approaches to research

The scope and scale of problems and challenges associated with climate change, and climate compatible development – as shown in the needs analysis of this mapping study Country Report – require new forms of knowledge production. Multi-, inter- and transdisciplinary approaches to research are emerging in this context, from an understanding that research modelled on a 'business as usual' approach will not drive ingenuity in resolving complex social-ecological challenges like climate change.

Historically, the dominant approach to research is based on research in the single discipline. While single discipline research remains extremely important for development of in-depth and high quality knowledge, there is also a need to expand these approaches over time towards new, institutionally more complex forms of knowledge production.[19] Figure 5 below shows that over time, research can build towards and include a wider range of research approaches that include multi-, inter- and transdisciplinary research approaches.

Note: Diagram showing research approaches and how they can emerge over time, in relation to outcomes that meet societal needs in the context of complex problems that need to be resolved such as climate resilient development.[20]

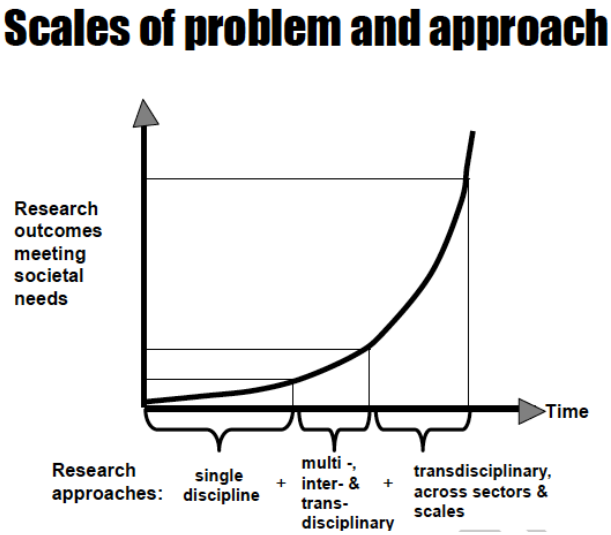


Figure 5: Research approaches

[19] This is because universities are organised and established around a disciplinary knowledge production structure.

[20] Source: Palmer, Lotz-Sisitka, Fabricius, le Roux & Mbingi, in press.

There is global evidence that more researchers are beginning to expand the single discipline approach to research, to include multi-, inter- and transdisciplinary approaches, and through this, their research is engaging across sectors and scales, and with changing social-ecological systems, complexity and integration.

Researchers working with these approaches argue that research outcomes that are generated in this manner have a greater chance of meeting societal needs.[21]

These emerging approaches to research are clarified below.

Multidisciplinarity

This involves using different disciplinary studies to address a common empirical focus or problem. Existing disciplinary methods and structures are not changed in multidisciplinary research. Multidisciplinary research helps to develop different 'angles' or different understandings of a problem, from the vantage point of different disciplines.

Interdisciplinarity

This marks a position between multi- and transdisciplinarity. It involves multidisciplinary studies, but takes these further by synthesis work that takes place *across* the different disciplines. It involves the development of a common framework and perhaps the use of discipline-transcending terminology and methodologies while maintaining certain critical disciplinary distinctions. Important in interdisciplinary research are processes of synthesis and a 'blending' or relating of knowledge from different disciplines.

Transdisciplinarity

This entails using strategies from interdisciplinary research, but it also involves taking this further into development of new theoretical understanding and new forms of praxis that are needed across sectors and at different scales. These are based on an inter-penetration of disciplinary perspectives or understandings, and a 'creative re-deployment' of these in contexts of practice[22], often contexts that are complex.

It is possible to differentiate between 'weak transdisciplinarity', which only relates existing knowledge to practice and 'strong transdisciplinarity', which more deeply into developing new and more complex ways of understanding and engagement in contexts where new forms of theory and practice come together[23] across sectors and at different scales.

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[21] There is a growing body of scientific work that reflects this perspective. See for example: Hirsch Hadorn, G., H. Hoffmann-Riem, S. Biber-Klemm, W. Grossenbacher-Mansuy, D. Joye, C. Phol, U. Wiesmann and E. Zemp (eds). 2008. *Handbook of Transdisciplinary Research*. Springer.

[22] Bhaskar, R. 2010. "Contexts of interdisciplinarity: interdisciplinarity and climate change." In *Interdisciplinarity and Climate Change. Transforming knowledge and practice for our global future,* edited by R. Bhaskar, F. Frank, K. Hoyer, P. Naess and J. Parker. London: Routledge.

[23] Max Neef, M. A. 2005. "Commentary: Foundations of Transdisciplinarity," *Ecological Economics* 53: 5-16.

Transdisciplinarity involves different modes of reasoning: the rational, the relational and the practical. Transdisciplinarity research presents an 'unfinished scientific programme' that offers fascinating possibilities for advanced reflection and research.[24] This is increasingly being seen as a real opportunity for innovation. Transdisciplinary research, oriented towards knowledge production for societal change, can be seen as a process that can develop over time.

Knowledge co-production

Traditionally (and currently) most research partnerships and funding arrangements still focus on the single discipline. However, international research platforms are changing towards inter- and transdisciplinary knowledge production, especially in the social-ecological sciences. Engaging in inter- and transdisciplinary knowledge production (because of its interest in new synthesis and creative deployment of knowledge in contexts of practice across scales and sectors) requires new ways of relating, thinking and doing.

As a result, new partnerships are needed between researchers and a wider range of societal actors. Movement in this direction depends on: 1) society becoming widely involved in the research domain (this includes researchers, managers, practitioners and civil society); 2) time investments to develop the trust between and competence of research partners and participants; and 3) a willingness to recognise that there are different forms of knowledge that need to interact for societal change to occur; and 4) learning by doing, or social learning.[25] Knowledge co-production is also referred to as knowledge co-creation. This requires working to bring together different contributions in the knowledge production process.

5.1.2 The current 'status' of multi-, inter- and transdisciplinary approaches to research and knowledge co-production

The University of Dar Es Salaam College of Education, the University of Dodomo and the University of Iringa all claimed to be participating in either interdisciplinary or multidisciplinary research; however specific details of this research was not provided in the questionnaires. In the workshop discussions, it was noted that while research collaboration on climate change was there in practice, there may not be clarity regarding the category into which it would fall. Thus there is a need for a more structured approach to the design of collaborative research.

Workshop discussions highlighted issues surrounding the enabling of collaboration, raising the challenge of working on a collaborative project, while maintaining a sense of authorship and promotion of your own discipline. A further challenge was that of working with different mindsets, and what was termed as "issues of superiority-inferiority complexes" that arise in such research, where lack of trust and respect at discipline level is experienced. Currently the weak link between government institutions and universities was seen to inhibit this form of research, as well as the challenge of trying to consolidate the various theories to a single

[24] Max-Neef. 2005. "Commentary: Foundations of Transdisciplinarity".

[25] Adapted from the Akili Complexity Forum draft proposal, NRF South Africa (March 2010).

practice. One participant in the workshop raised the concern that donor driven research affects the potential for multi-, inter- and transdisciplinary research. Some participants felt that this kind of research would benefit greatly through the integration of the local communities in the design of research to be carried out, including with respect to the proposed and implemented interventions.

In addition to existing centres for multidisciplinary research, such as UDSM's Institute of Resource Assessment and Climate Change Centre, and various departments in Sokoine University of Agriculture, the newly established Tropical Research Centre for Oceanography, Environmental and Natural Resources (TROCEN), located in State University of Zanzibar School of Natural and Social Sciences, will have a multidisciplinary focus and will also serve as a training hub. TROCEN will promote and disseminate research findings on coastal protection, oceanography and climatic change; and aims to produce graduates who have working knowledge on Zanzibar natural resource exploration, environmental pollution and control.

5.1.3 Possibilities

From this discussion it is clear that some of the following need to be addressed if transdisciplinary knowledge co-production processes are to emerge in response to CCD concerns:

- Strengthening of research collaboration;
- Incentives for inter- and transdisciplinary research;
- Reconcile multiple theories with practice/methodology;
- Funding for such research;
- Publishing support and other knowledge transfer that encourages multidisciplinarity; and
- Developing collaborative research cultures.

As indicated above, the need for such research is acknowledged, multiple research partnerships are possible within the stakeholder networks that are interested in CCD research, and there is an understanding of the societal benefit of such approaches to research. However, research systems and cultures of practice in universities are not 'set up' to support such research innovation.

Towards overcoming the issue of inadequate collaboration amongst researchers from different disciplines/institutions and the private sector, the 2010 National Research and Development Policy states that the government shall establish a legal and administrative framework to promote partnership, networking and collaboration across disciplines, the private sector and R&D institutions; promote R&D activities which are carried out by conglomerates of R&D institutions; and encourage R&D institutions to formulate their own research policies that will promote collaboration in line with the national research policy. This could be further explored as a mechanism to further develop collaborative research on climate change.

In the next section, a possible CCD knowledge co-production pathway is mapped out based on the analysis in sections 2, 3 and 4. If expanded, this approach could provide a way forward to develop a broad-based research agenda for CCD in Tanzania, which would need to be co-designed and refined at a local level by participating organisations and groups.

6 SUMMARY AND CONCLUSION

6.1 Synthesis perspective knowledge, research, individual and institutional capacity needs analysis

Tanzania has observed increasing frequency and severity of droughts, as well as increased flooding and tropical storms in recent decades. Despite projections for an overall increase in rainfall, the country has detected a statistically significant decrease in rainfall, as well as increasing inter-annual variability. Observed average temperature has increased by 1˚C since 1960, with projections of up to 4.5 ˚C increases, or higher, by the end of the century, should global emissions rates not decrease radically. The country is extremely vulnerable to increasing climate variability and climate change, given the high dependence on natural resources of the economy and of most people's livelihoods, and its high levels of poverty. Shortages of food and increases in malnutrition could hit the country hard. As participants in the mapping study stated, 'Climate change concerns survival'. The study has revealed that while understandings of CCD differ between stakeholders and university staff involved in the field, there is generally a close conceptual association between climate compatible development and **adaptation and mitigation**, and climate compatible development and **sustainable development**.

Within this context, the needs analysis for Tanzania revealed that despite some significant existing expertise, as well as good prospects for emerging expertise in the field, CCD knowledge and research will need to be greatly enhanced in both specific and cross-cutting ways to address the considerable observed and projected impacts. In this regard, findings of this study could be helpful in the future implementation of the National Climate Change Strategy (NCCS), as well as related policy development and implementation for mainstreaming climate change.

6.1.1 Broad adaptation and mitigation needs

The mapping study revealed support across all data sources for the broad adaptation strategies prioritised in the NCCS, namely water resources, coastal and marine environment, forestry, wildlife, agriculture and food security, human health, tourism, energy, industry, livestock, fisheries, infrastructure, human settlements, and land use. Workshop and questionnaire responses highlighted additional broad priority areas in the important role of ecosystems services, as well as education and communication. The mapping study found consensus between all three sources of data that while the focus should be on adaptation, given its negligible GHG emissions, Tanzania can participate in mitigation activities to contribute to its sustainable national development. Mitigation priority areas include land use, agriculture and forestry, energy, transportation systems, and waste disposal activities.

6.1.2 Specific knowledge and research gaps

The mapping study data shows that key **knowledge gaps** focus on improving the curricula, baseline information, long term, developing a climate change data base; improving the balance between conservation and tourism development; the rate of GHG emissions due to deforestation and forest degradation; improved agronomy practices and a need to improve

technological knowledge. The **research gaps** highlighted in this study point primarily to, that focus on biodiversity, agriculture, food security, modelling, and water resource management primarily, but also explore issues of sea level rise, coastal development, tourism, disaster risk management and specific energy related mitigation.

6.1.3 Cross-cutting needs

Information and data-related gaps include inadequate baseline information, lack of long-term data and time series data, inadequate climate projections and weather prediction, the need to digitise data that does exist, and lack of a climate change database to house relevant information. Overall, the need to harmonise and consolidate research efforts in Tanzania was highlighted, as well as the importance of raising awareness, improving the curricula content relating to climate change and CCD, and research in this regard.

6.1.4 Notable themes

Participants in the Tanzanian mapping study placed emphasis on the role of indigenous knowledge in climate proofing agriculture and food security, as well as the critical role of ecosystem services for enabling both adaptation and mitigation, and in underpinning the important tourism industry. There was also a focus on the need to design CCD research so that it addresses the needs of poor and marginalised communities; this was also specifically related to the need for integrated adaptation-mitigation approaches, so that mitigation initiatives such as REDD+ do not impact negatively on access rights and livelihoods of people.

6.1.5 Individual capacity gaps

The mapping study shows that in order to further enhance co-production possibilities in Tanzania, a wide range of individual capacities need attention. These include more specific, technical or disciplinary gaps, such as climate change observation and climate modelling, GIS skills, EIA competencies, biotechnology, environmental regulations enforcement, climate change expertise in the tourism sector, fire modelling experts in forest ecosystem management, and a range of individual capacities in the area of climate change and agriculture. More cross-cutting individual capacities required are financial and resource mobilisation, monitoring and evaluation competencies, technology management competencies, conflict resolution skills, information sharing and database management capacities. In general, more climate change and CCD-informed managers, researchers, service providers and modellers are required.

6.1.6 Institutional capacity gaps

The mapping study found that knowledge co-production for CCD requires developing institutional capacities for improved multi-sectoral coordination and collaboration, policy harmonisation and enforcement, and integrated approaches to development. An effective research – policy interface would be critical for science- and evidence-based decision making. To address the identified needs, teaching facilities and curricula need to be extended and

better institutional repositories information centres developed. In addition, conflicting institutional mandates were identified as a key institutional capacity gaps.

6.2 Synthesis perspective on the institutional assessment

This mapping study has identified existing initiatives amongst the HEIs in Tanzania and their partners where activities such as research, teaching, policy engagement and community outreach are addressing climate change-related needs. The study has shown that HEIs in Tanzania do have relatively good expertise and capacity for responding to climate change and moving towards CCD, as do other stakeholders. Active researchers identified in this mapping study are listed in Appendix B, and CCD areas of expertise in Tanzania, mainly with respect to universities, are summarised in the table in Appendix E.

Critical issues to address in Tanzania in a broad sense are the need to create an effective research – policy interface, to enable science-based and evidence-based decision making; and to design research on CCD needs to address needs of poor and marginalised communities. The need for greater collaboration and integration was highlighted, both in research and implementation. For example, participants in the mapping study stressed that an integrated approach to adaptation and mitigation was required to ensure that mitigation interventions (e.g. REDD+) do not impact negatively on access rights and livelihoods of people – i.e. to avoid maladaptation. A critical issue is the establishment and strengthening of linkages between R&D institutions, academia and the productive sectors' activities.

Specific enablers for knowledge co-production per sector provided some key insights into enabling more collaborative research in Tanzania. Governments were suggested to make environmental education mandatory in the education system, provide regulatory frameworks to deliberately integrate policy and research; encourage stakeholder collaboration; harmonise the policy into national climate change response strategy; approach policy implantation from the bottom up and empower communities to run their own projects in CCD. Governments were also suggested to involve universities and the private sector in policy making and also embrace traditional and indigenous knowledge systems in these activities. Participants felt the donors could encourage knowledge co-production by providing financial support through grants rather than loans; collaborate with NGOs, universities and government; should have a clear agenda and interest in CCD projects and should try to be more flexible and accommodate the researched needs and development in this area. Despite these suggested enabling conditions, universities were seen to hold the most important responsibility in enabling knowledge co-production, particularly in creating environments for multi-, inter-, and transdisciplinary research.

National stakeholders and university stakeholders seemed to have a strong understanding of the need for CCD and the needs and potential gaps in future CCD responses. Of interest are their interpretations of the priorities and needs, which are diverse and cover a range of areas, that relate somewhat to their disciplines or mandates, but also extend further out beyond their specific interests, revealing the interdisciplinary and multi-sectoral nature of climate change. The combination of an engaged growing legislative movement and a broadening understanding of the particular needs for climate change and CCD in Tanzania makes a fertile

environment for the development of co-production possibilities. Even with the growing engagement of government, participants felt this was not enough and a more attentive, motivated and well-resourced approach was required from government. Alongside this improved transfer of knowledge and dissemination of research and more dedicated funding and resourcing of CCD in Tanzania were highlighted. In further developing knowledge co-production opportunities, two key priority areas were established. These included curriculum development/ awareness raising and improved involvement of government and policy makers in revising and expanding legislation for CCD.

The need for improved institutional support seemed to be the greatest area of concern among participants in the mapping study, as also supported by policy documents such as the 2003 Initial National Communication to the UNFCCC. Mechanisms are particularly needed for institutions to fully support, nurture and enable collative forms of inquiry, and knowledge co-production projects, particularly in curriculum development. This will require improving the information management systems available in the country; enforcement/ implementation of policies and strategies as well as promoting and supporting inter-institutional cooperation.

Generally, then, an integrated approach to knowledge, research, individual and institutional capacity development is needed in Tanzania where improved resourcing, and more active and attentive government and legislative support is offered. This will allow appropriate research agendas and curriculum development to occur, further enabling the wider climate change and CCD related research community in Tanzania, and ensuring that positive relevant developments enabled through climate change projects, such as the creation of a climate change observatory for Tanzania, which is an outcome of the 2012 – 2017 Adaptation Fund programme.[26] A key initial step could be to develop a clear set of national research priorities for CCD in the country, as well as strategies to enable research on these. A potential sectoral model for this lies in the Tanzania National Health Research Priorities for the period 2013 – 2018, as developed in 2013 by the National Institute for Medical Research.

6.3 A broad map of Tanzania CCD knowledge co-production pathways

Considering the workshops and questionnaires, as well as other data sets in relation to each other; one can begin to map out CCD capacity development pathways for Tanzania. One example is offered here (Table 14) for a key CCD priority area in Tanzania, namely **sustainable agricultural production for food security in the context of climate change vulnerabilities.** This is an important adaptation priority for the country, which can be implemented in a way that harnesses developmental mitigation synergies. The table provides a synthesised perspective of key knowledge, research, individual and institutional capacity gaps for Tanzania for this priority area, providing insight into the research, capacity building and institutional development pathways needed for enhancing future contributions to CCD.

[26] The programme is entitled 'Implementation of Concrete Adaptation Measures to Reduce Vulnerability of Livelihoods and Economy of Coastal and Lakeshore Communities in Tanzania'.

Table 14: CCD Knowledge, research, capacity building and institutional capacity gap analysis for one of Tanzania's adaptation priorities: Sustainable agricultural production for food security in the context of climate change vulnerabilities

CCD PRIORITY	Knowledge and Research Gaps (Research agenda)	Individual Capacity Gaps (Education and training agenda)	Institutional Capacity Gaps (Institutional development agenda)
ADAPTATION: ▪ Sustainable agricultural production for food security in the context of climate change vulnerabilities	▪ Knowledge on reasons for unstable production trend ▪ Inadequate awareness on climate change ▪ Inadequate knowledge on weather prediction ▪ Knowledge on improved agronomy practices ▪ Causes / likelihood of ecological shifts, related to climate change ▪ No research information on high yielding and CC tolerant crops ▪ Inadequate information of new and old diseases ▪ The available data are not harmonised ▪ Assessment of ecological zones at local scale ▪ Studying and disseminating new technologies and management systems that improve on the indigenous knowledge of the agro-pastoralist and pastoralist ▪ Continuous assessment of climate change impact on grassland and livestock particularly in the country's marginal regions to ascertain ways to increase and sustain livestock production with minimum environmental degradation ▪ Studies on livestock that are more tolerant to diseases and drought ▪ Research on agro-chemicals to counter diseases and pests that would probably increase with climate change ▪ Research on the development of pasture and tree fodder crops to enhance the sustainability of livestock and dairy cattle if climate changes occur	▪ Inadequate expertise in climate change and agriculture ▪ Lack of analytical tools among agricultural researchers, extension officers and agronomists ▪ Inadequate technology management competencies	▪ Inadequate agricultural research centres ▪ Lack of centralised data base ▪ Inadequacy of integrating climate change in agricultural plans, programmes, policies and strategies ▪ Mechanisms to promote sustainability of projects ▪ Poor coordination on issues of CCD on government ▪ Limited understanding of relationship between issues of habitat health and climate change ▪ Limited multi-sectoral coordination ▪ Inadequate institutional arrangements

Knowledge co-production pathways such as the one modelled above can be developed for all major CCD priorities. Key is to integrate mitigation, adaptation and development priorities into the CCD knowledge co-production pathways where appropriate, as per the CCD framework.

Workshop participants felt that as the SARUA workshop enabled networking among different stakeholders with a range of perspectives, this could be the beginning of an important national platform on climate change and CCD. To further develop this, critical issues to be addressed for Tanzania to expand its CCD knowledge co-production capacity are:

- Further consolidate the national knowledge co-production analyses based on the needs and institutional analyses in this country mapping study, and as modelled in the example above (Table 14), to guide further action at country level.
- Expand the capacity of the research institutions that have been identified as having some capacity and expertise for research, teaching and learning on CCD. Develop strategies for strengthening individual research competence, so that individual interest and research capacity can grow into a 'node of expertise' and then into a 'centre of expertise', and potentially a Centre of Excellence.
- Strengthen the collaborative, transdisciplinary potential within Tanzanian universities and other institutions to improve the opportunities for more reflexive and dynamic forms of research that can contribute to meaningful CCD in Tanzania.
- Strategic policy support from the climate compatible development policy community and the Higher Education community will be needed to facilitate such capacity building pathways in Tanzania.
- Improve co-operation, communication, knowledge management and shared access to data at all levels.
- Develop motivation and incentives for researchers, especially for engaging in multi-, inter and transdisciplinary research approaches. Support capacity development of researchers in these areas.
- Strengthen research partnerships and research infrastructure, including research funding and incentives for students.
- Support ongoing processes of curriculum innovation to mainstream CCD into existing courses and programmes, and engage in development of Masters Degree curriculum design, potentially in partnership with other southern African universities.
- Strengthen existing policy and community outreach activities within a knowledge co-production framework, building on promising activities; and develop tools for monitoring and dissemination to make the impact of such work visible within the university system.
- Develop campus management policies and practices that demonstrate commitment to CCD at the institutional level, and support student organisations that are beginning to tackle CCD-related matters.

6.4 Possibilities for linking into a networked system of knowledge co-production in the SADC region

Climate Change and CCD research and teaching in Tanzania includes expertise in both adaptation and mitigation-related fields, as well as experience in integrated adaptation-mitigation approaches. Particular areas of strength identified in Tanzania include:

- **Climate services**: Climate modelling
- **Climate change adaptation research**: Food security and climate change, natural resource management, enhancing pro-poor innovations in natural resources and agriculture value chain, conservation and tourism
- **Climate change mitigation research:** Modelling of ecosystem services for carbon storage
- **Integrated adaptation-mitigation research:** Developmental and pro-poor approach to REDD+; management of natural resources for sustainable agriculture
- **Cross-cutting issues research**: Education for sustainable development, indigenous knowledge systems and climate change
- **Systems of social change research**: Environment, health and climate change
- **Teaching and curriculum innovation:** Environment and health, sustainable agriculture, including Masters degree in Management of Natural Resources for Sustainable Agriculture, Masters degree (MSc) in Climate Change and Sustainable Development

APPENDIX A: WORKSHOP ATTENDANCE LIST

List of participants at Tanzania workshop, 25 September 2013 (Day 1)

Room B 106 University of Dar Es Salaam School of Business Building (UDBS Building) Main Campus

Full name	Department/faculty/organisation	Designation	Contact number/s	Email address
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List of participants at Tanzania workshop, 26 September 2013 (Day 2)

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Innocent Semali	MUHAS-Epidemiology/Biost	Senior Lecturer	0754269838	innosemali@yahoo.com

APPENDIX B: ACTIVE RESEARCHERS IDENTIFIED WHO ARE CONTRIBUTING TO CC /CCD RELATED RESEARCH ACTIVITIES

Table 15: Active researchers who are contributing to CC/CCD related research in Tanzania

Name and qualification	Department / Area of expertise	Years of experience: Years of experience in CC research	Contact details
Pius Z. Yanda (PhD)	Physical geography/climate change	24 years	University of Dar Es Salaam Professorial Chair: Environment and Climate Change Director: Institute of Resource Assessment yanda@ira.udsm.ac.tz
Buruhani S. Nyenzi (PhD)	Physical climate/ climate services		Climate Consult (T) Ltd. Previously Head of World Climate Programme, World Meteorological Association bnyenzi@yahoo.co.uk
Prof. Claude G. Mung'ong'o (PhD)	Environmental sociology		University of Dar Es Salaam Institute of Resource Assessment
P.K.T. Munishi (PhD)	Ecosystems, biodiversity and climate change		Sokoine University of Agriculture-Forest Biology Department Pmunishi2001@yahoo.com
Zabron Kengera(MSc)			University of Dar es Salaam, Department of Geography zkengera@yahoo.com
Prof S. Mwakalila (PhD)	Community-based adaptation and sustainable water resources management		University of Dar es Salaam
Halima Kilungu			Open University of Tanzania kilunguh@yahoo.com
Haji Mweyuka			State University of Zanzibar, School of Natural and Social Sciences
Dominique Andrew Lukiko (Masters)	Geography/ CC impact on Ecosystem function	8 years : 4 years	University of Dar Es Salaam College of Education (DUCE), Humanities and Social Sciences, Geography mydlukiko@yahoo.co.uk
Evaristo Haulle (Masters)	Geography/ Impact of CC to food production	11 years : 8 years	Mkwawa University College of Education, Humanities and Social Sciences, Geography haulledict@gmail.com

Name and qualification	Department / Area of expertise	Years of experience: Years of experience in CC research	Contact details
Hector Mongi (Masters)	Information Systems	Unspecified: 13 years	University of Dodoma, Informatics, Information Systems hjmongi@yahoo.com
Leatitia Gabriel Mashaza	Education, ESD education	7 years: 4 years	Dar Es Salaam University College of Education, Faculty of Education, Curriculum and Teaching leatitiagabriel@yahoo.co.uk

Note: This list is based on information provided in the country workshop and from completed questionnaires, plus limited additional internet research, and is therefore indicative rather than definitive.

APPENDIX C: UNIVERSITIES QUESTIONNAIRE

QUESTIONNAIRE FOR UNIVERSITY MANAGERS, TEACHING AND RESEARCH STAFF: Status of Climate Compatible Development Research, Teaching and Policy / Community Engagement

A: GENERAL INFORMATION

A1: NAME	
A2: GENDER	
A3: HIGHEST QUALIFICATION	
A4: JOB TITLE	
A5: YEARS OF EXPERIENCE	
A6: YEARS OF EXPERIENCE WITH CLIMATE CHANGE / COMPATIBLE DEVELOPMENT RELATED ISSUES	
A7: NAME OF UNIVERSITY	
A8: COUNTRY	
A9: NAME OF FACULTY	
A10: NAME OF DEPARTMENT	
A 11: NAME OF PROGRAMME/ CENTRE / UNIT / INSTITUTE	
A12: E-MAIL CONTACT	
A13: WEBSITE ADDRESS:	

B: GENERAL VIEWS

B1: Give a short description of **how you understand** 'climate change'

B2: Give a short description of **how you understand** 'climate compatible development' in your context

B3: What, in your view, are the most **critical aspects** to deal with in your country if 'climate compatible development' is to be achieved?

B4: In your view, what is **the role of universities** in contributing to the achievement of climate compatible development?

B5: In your view, what is the **role of university managers** in contributing to achievement of climate compatible development?

C: CAPACITY, KNOWLEDGE AND RESEARCH GAPS

Please indicate if you are answering these questions on behalf of a:

University	
Faculty	
Department	
Programme / Centre / Institute	

	Rate the contributions of your university / faculty / department / programme using 1-5 with 1 being non-existent, and 5 being very active or well developed	**1**	**2**	**3**	**4**	**5**
C1	Involvement in research in the area of climate change and/or climate compatible development					
C2	Involvement in **local** climate change and/or climate compatible development research					
C3	Involvement in **national** climate change and/or climate compatible development research					
C4	Involvement in **international** climate change and/or climate compatible development research					
C5	Involvement in single discipline approaches to climate change and/or climate compatible development research					
C6	Involvement in **inter-disciplinary** approaches to climate change and/or climate compatible development research					
C7	Involvement in **transdisciplinary** approaches to climate change and/or climate compatible development research					
C8	Involvement of multiple stakeholders in climate change and/or climate compatible development research					
C9	Record of raising funding for climate change and/or climate compatible development research					
C10	Contributions of the research to local climate compatible development pathways					
C11	Contributions of the research to national climate compatible development pathways					

C12: Would you describe your university / faculty / department / programme's research primarily as being focused on:

Climate Change	
Climate Compatible Development	
Other (please specify)	

C13: List major research projects / programmes focusing on climate compatible development in your university / faculty / department / programme:

C 14: List the most active researchers involved in climate change and/or climate compatible development research in your university / faculty / department / programme, and their 'specialist' areas of research and if possible give an email contact address

C 15: List any major practices and research initiatives you or others regard as innovative in your university / faculty / department / programme, and their 'specialist' areas of research, and if possible provide a contact name and email of a person responsible

C16: List any major research or knowledge production networks that you may be involved in that focus on or support knowledge production and / or use that is relevant to climate compatible development in your context? If possible, provide a contact name and email address for the person responsible for the network:

D: CURRICULUM, TEACHING AND LEARNING

Rate the contributions of your university / faculty / department / programme using 1-5 with 1 being non-existent, and 5 being very active or well developed		***1***	***2***	***3***	***4***	***5***
D1	**Specialist courses** offered on climate change / climate compatible development					
D2	Climate change / climate compatible development issues and opportunities **integrated into existing courses**					
D3	**Cross faculty teaching** on climate change / climate compatible development					
D4	**Inter- and/or transdisciplinary teaching approaches** used for climate change / climate compatible development courses					
D5	**Service learning** (accreditation of community engagement as part of formal curriculum) focusing on climate change / climate compatible development concerns					
D6	Courses develop **critical thinking** and **integrated problem solving** skills					
D7	Courses clearly focus on development of **social and/or technical innovation** and **ethical actions**					
D8	Climate change / climate compatible development aspects are included in **assessment and examinations**					
D9	**Staff willingness** to get involved in new issues such as climate change and/or climate compatible development					
D10	**Staff ability** to get involved in new issues such as climate change and/or climate compatible development					

D11: List any main courses in climate change / climate compatible development in your university / faculty / department / programme and indicate if they are undergraduate (1st, 2nd, 3rd year etc.) or postgraduate (Hons, Masters, PhD)

D 12: Give an example of one or two teaching methods that you would use for teaching climate change / climate compatible development in your courses

E: POLICY / COMMUNITY ENGAGEMENT AND STUDENT INVOLVEMENT

Rate the contributions of your university / faculty / department / programme using 1-5 with 1 being non-existent, and 5 being very active or well developed		**1**	**2**	**3**	**4**	**5**
E1	Involvement in climate change / climate compatible development policy outreach / engagement activities					
E2	Involvement in climate change / climate compatible development community outreach / engagement activities					
E3	Student involvement (e.g. through societies, clubs etc.) in climate change / climate compatible development activities on campus and in the surrounding areas					

E4: List any major climate change / climate compatible development **policy** outreach / engagement activities and if possible, the person responsible for the programme:

E5: List any major climate change / climate compatible development **community** outreach / engagement activities and if possible, the person responsible for the programme:

E6: List any major student organisations / activities that are engaged with climate change / climate compatible development activities

F: UNIVERSITY COLLABORATION

What opportunities exist for collaboration towards climate compatible development knowledge co-production?

F1: Inside the university

F2: Between universities in country

F3: With partners

F4: Regionally

F5: Internationally

G: UNIVERSITY POLICY AND CAMPUS MANAGEMENT

G1: Does the university have any policies that are aligned with climate compatible development objectives? If yes, then please list them.

G2: Does the university engage in any campus management activities that are aligned with climate compatible development objectives? If yes, then please list them.

G3: Are there major networks / research groups or programmes that the university is affiliated to that focus on climate compatible development? If yes, please list them.

APPENDIX D: STAKEHOLDER QUESTIONNAIRE

SHORT QUESTIONNAIRE FOR STAKEHOLDERS on CLIMATE COMPATIBLE DEVELOPMENT KNOWLEDGE, RESEARCH AND CAPACITY NEEDS

A: GENERAL INFORMATION

A1: NAME	
A2: GENDER	
A3: HIGHEST QUALIFICATION	
A4: NAME OF ORGANISATION	
A5: NAME OF SECTION / DEPARTMENT IN ORGANISATION	
A6: JOB TITLE	
A7: YEARS OF EXPERIENCE	
A8: YEARS OF EXPERIENCE WITH CLIMATE CHANGE / COMPATIBLE DEVELOPMENT RELATED ISSUES	
A9: COUNTRY	
A10: EMAIL CONTACT DETAILS	
A11: WEBSITE ADDRESS	

B: GENERAL VIEWS

B1: Give a short description of **how you understand** 'climate change'

B2: Give a short description of **how you understand** 'climate compatible development' in your context

B3: What, in your view, are the most **critical aspects** to deal with in your country if 'climate compatible development' is to be achieved?

C: CAPACITY, KNOWLEDGE AND RESEARCH GAPS

C1: What, in your view, are the most critical **knowledge gaps** that need to be addressed for achievement of climate compatible development in your context?

C2: What are your most critical **specific research needs** for achieving climate compatible development in your context?

C3: What, in your view, are the most critical **capacity gaps** (individual skills and institutional capacity) that need to be addressed for achievement of climate compatible development in your context?

C 4: In your view, what is **the role of universities** in contributing to the achievement of climate compatible development?

C5: In your view, how could / should **your organisation** be collaborating with universities to strengthen climate compatible development in your country?

D: INTERESTS, POLICIES, NETWORKS AND CENTRES OF EXCELLENCE OR CENTRES OF EXPERTISE

D1: Briefly describe your organisation's main interest in climate change / climate compatible development

D2: List any major policies and plans that have relevance to climate change / climate compatible development in your country and/or organisational context

D3: Briefly describe any collaboration that you have had with universities and/or research, learning and innovation centres, etc. on mobilising knowledge and capacity for climate change / climate compatible development. List the specific initiative / collaboration, and if possible give details of a person responsible for this.

D4: Are there any national centres of excellence in climate change / climate compatible development research and innovation practices in your country? If yes, please list them and indicate their specialist competence areas.

D5: Is there any specialist expertise in your country / context for climate change / climate compatible development research and learning that you know of? If yes, please list who they are, and indicate their specialist competence areas.

D6: Are there any networks that are engaging with climate change / climate compatible development research and innovation practices in your country? If yes, please list them, and indicate what they focus on. If possible, list a responsible person (with contact details if possible).

APPENDIX E: IDENTIFIED SOURCES OF EXPERTISE FOR CCD IN TANZANIA

Table 16: Identified sources of expertise for CCD in Tanzania

University/ organisation	Nodes of expertise	Centres of expertise	Centres of excellence	Active CCD related Research Networks
University of Dar Es Salaam (UDSM	Faculty of Science: ▪ Department of Geography: several researchers working on local knowledge and CC	UDSM Institute of Resource Assessment: ▪ Wider experience on CCD related research projects; housing Centre for Climate Change; Masters Programme; Secretariat for REDD UDSM Institute of Marine Science (Zanzibar) ▪ Also houses Tanzania National Oceanographic Data Centre Sokoine University of Agriculture ▪ Centre for ecosystem analysis and climate change Tanzania Meteorological Agency (TMA) ▪ Has two departments dealing with climate change, with more than 6 PhDs, more than 30 people with Masters degrees; range of CC skills including dynamical downscaling	University of Dar es Salaam: ▪ Mwalimu Julius Nyerere Professorial Chair: Environment and Climate Change, held by Prof. Pius Yanda	▪ Forum CC Tanzania ▪ Zanzibar Climatic Change Alliance ▪ OSSREA Tanzania chapter (Organisation for social science and research in east Africa) ▪ START ▪ Tanzania Natural Resource Forum ▪ Institute for Environment and Sustainable Devt. ▪ Lawyers Environmental Action Team-LEAT
Sokoine University of Agriculture	Department of Forest Biology, other departments ▪ Group of active and experienced researchers working on ecosystems ad CC, IK on CC, vulnerability assessments, management of natural resources for sustainable agriculture	PROSPECTIVE: Tropical Research Centre for Oceanography, Environmental and Natural Resources (TROCEN), located in State University of Zanzibar, School of Natural and Social Sciences ▪ Newly established, will have multidisciplinary focus; training hub		

Note: This analysis is based on best available evidence, within the constraints of the mapping study. With further information and evidence, it can be expanded, and also used for monitoring and updating of CCD expertise in Tanzania.

APPENDIX F: LIST OF CCIAM PROJECTS ON ADAPTATION AND MITIGATION APPROACHES IN TANZANIA, WITH A FOCUS ON REDD+

CCIAM PROGRAMME RESEARCH and INTERVENTION PROJECTS

	TITLE	RESEARCHERS INVOLVED FROM NORWAY (excl. PhD students)
1	Quantification, modelling and mapping carbon stocks and plant diversity in different land cover types in Tanzania **Prof. P.K.T. Munishi (SUA), project coordinator**	Prof S.R. Moe (UMB) Prof. Ø. Totland (UMB)
2	Development of biomass estimation models and carbon monitoring in selected vegetation types in Tanzania **Prof. R. E. Malimbwi (SUA), project coordinator**	Prof. T. Eid (UMB) Prof. O.M. Bollandsås (UMB)
3	Climate change, non-timber forest products and livelihood of forest dependent communities: Impacts, vulnerability and adaptation in Tanzania **Dr. S. Augustino (SUA), project coordinator**	Dr. S. Eriksen (UMB) Dr. L.O. Næss (CICERO)
4	Developing fire reduction strategy for Miombo woodlands as a potential tool for carbon storage and sequestration **Prof. S.S. Madoffe (SUA), project coordinator**	Prof. F. Midtgaard (UMB)
5	Comparative study of incentive mechanisms under REDD and non-REDD situations in Kilwa and Lindi Districts, Tanzania **Prof. K. Kulindwa (UDSM), project coordinator**	Prof. H. Lein (NTNU)
6	Economic Valuation of Incremental Biomass under PFM and its Potential to serve as Management Incentives under REDD initiatives in Tanzania **Dr. L.P. Lusambo (SUA), project coordinator**	Prof. F. Midtgaard (UMB)

	TITLE	RESEARCHERS INVOLVED FROM NORWAY (excl. PhD students)
7	Establishment of Harmonized Modalities and Mechanisms for Community Compensation and Carbon Markets: The Case Study of REDD Pilot Projects in Tanzania **Dr. R S. Shemdoe (ARU), project coordinator**	
8	REDD Architecture in Tanzania: Assessment of REDD options for Livelihood Security and Sustainable Development **Dr. Dos Santos Silayo (SUA), project coordinator**	Prof. A. Vatn (UMB) Prof. P. Vedeld (UMB) Dr. D. Kjosavik (UMB)
9	Governance, incentives and monitoring in REDD- GIM-REDD Prof. J.F. Kessy (SUA), project coordinator	Prof. Arild Angelsen (UMB) Prof. F. Midtgaard (UMB)
10	Governance Challenges in REDD Implementation in Tanzania: Experiences from Participatory Forest Management in Manyara and Lindi Regions **Dr. F. Maganga (UDSM), project coordinator**	Prof. T.A. Benjaminsen (UMB) Prof. O.H. Fjeldstad (CMI/UMB) Dr. K. Nustad (NUPI/UMB)
11	The role of local government in implementing REDD **Dr J. King'ori, (UDSM), project coordinator**	Prof. D. McNeill (UiO)
12	The role of indigenous knowledge in community adaptation and mitigation response to the impacts of climate change in Tanzania **Dr. A. L. Kijazi (TMA), project coordinator**	
13	Implications of REDD on Smallholders' Livelihoods through Access to Land in Manyara Region: Mapping and Assessment of Challenges and Opportunities **Dr. A. E. Majule (UDSM), project coordinator**	Prof. T.A. Benjaminsen (UMB) Dr. Hanne Svarstad (UiO) Prof. Vegar Bakkestuen (UiO)

	TITLE	RESEARCHERS INVOLVED FROM NORWAY (excl. PhD students)
14	Analysis of the impacts of urban land use and climate change on coastal forest ecosystem and management (IULUCC-CFM) **Dr J. Lupala (ARU), project coordinator**	
15	Impact of climate variability on fisheries and mangrove ecosystems based mariculture along the Tanzanian coast **Dr. B. V. Mnembuka (SUA), project coordinator**	Prof. I. Mayer (NVH)
	STRATEGIC INTERVENTION PROJECTS	
16	Strengthening Documentation, Communication and Dissemination of Information related to Climate Change Impacts, Adaptation and Mitigation in Tanzania **Prof. D. Matovelo (SUA), project coordinator**	Mrs. L. Ellingsen (UMB)
17	Appropriate intervention strategies to enhance carbon sinks and improve livelihoods of the local communities o fthe selected severely degraded environments through community participation **Dr. Abdallah, J.M., project coordinator**	
18	Alternative energy sources and efficient utilization of biomass energy for reduced depletion of carbon sinks and improved livelihoods in rural areas of Tanzania **Prof. Kweka, A.E., project coordinator**	Dr. G. Synnevåg (UMB)

	TITLE	RESEARCHERS INVOLVED FROM NORWAY (excl. PhD students)
19	Promotion and Intensification of Fruit Trees in Agricultural Farm Lands for Mitigation and Adaptation to Climate Change **Dr. Kusolwa, P.M., project coordinator**	
20	Small-holder Production Systems in Tanzania Striking a balance between intensification, sustainability, food security and climate **Prof. Mtengeti, E.J., project coordinator**	Prof. L.O. Eik (UMB) Prof. O. Hofstad (UMB) Prof. L.J. Asheim (NILF) Prof. Asbjørn Aaheim (CICERO) Prof. R. Haug (UMB) F. Stordal (UIO) R. Benestad (Meteorology Institute)
21	Economic assessment of climate change impacts, adaptation and vulnerability in Tanzania: The case of Pangani river basin **Prof. J.P. Hella (SUA), project coordinator**	Prof. R. Haug (UMB) Prof. P. Vedeld (UMB)
22	Rangeland management strategies for adaptation and mitigating climatic change in agro-pastoral communities **Prof. Mtengeti, E.J. (SUA), project coordinator**	Prof. B.R. Singh (UMB) Prof. F. Sundstøl (UMB)
23	Modelling scenarios of REDD+ in response to regulation of population **Dr. E. F. Nzunda (SUA), project coordinator**	Prof. F. Midtgaard (UMB)
24	Assessing leakage levels in REDD pilot project areas in Tanzania **Dr. M. Mdemu (ARU), project coordinator**	

	TITLE	RESEARCHERS INVOLVED FROM NORWAY (excl. PhD students)
25	Quantification of carbon stock changes under different forest tenure and their implication to livelihood in Miombo woodland, Tanzania **Prof. S.S. Madoffe (SUA), project coordinator**	Prof. F. Midtgaard (UMB)
26	Development of Integrated watershed and community-based climate change adaptation strategy for sustainable water resources management **Prof. S. Mwakalila(UDSM), project coordinator**	Dr. S. Movik (UMB)

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