



**Pathways for irrigation
development:
policies and irrigation
performance in Tanzania**
Working paper



Research for climate-resilient futures

Pathways for irrigation development: policies and irrigation performance in Tanzania

February 2017

Naomi Oates

Beatrice Mosello

Guy Jobbins

This working paper has been produced as part of a series of papers to guide the long-term research agenda of the Pathways to Resilience in Semi-arid Economies (PRISE) project. PRISE is a five-year, multi-country research project that generates new knowledge about how economic development in semi-arid regions can be made more equitable and resilient to climate change. This research was commissioned by FANRPAN as part of the project Increasing Irrigation Water Productivity in Mozambique, Tanzania and Zimbabwe through On-Farm Monitoring, Adaptive Management and Agricultural Innovation Platforms.

Front cover image:*

Groundwater workshop – Iringa, Tanzania.

© IGRAC

CC2.0 <https://creativecommons.org/licenses/by-nc/2.0/legalcode>

*This image has been modified from the original

Acknowledgements

We gratefully acknowledge the contributions of our peer reviewers: Makarius Mdemu (Ardhi University, Tanzania), Sithembile Ndema (FANRPAN), Andrew Coulson (University of Birmingham, UK) and Eva Ludi (ODI). We would also like to thank Makarius and Sithembile for their invaluable support in organising the Tanzania case study fieldwork.

Recognition is owed to Jessica Lillquist for her support in reviewing the literature on climate change and irrigation.

Finally, we would like to thank all the people we interviewed in the course of the project, who gave their time so generously and engaged in an open and constructive manner throughout. We have anonymised all quotations from interviews to ensure contributors could speak freely, but this in no way diminishes our debt to the individuals concerned.

This research was commissioned by FANRPAN as part of the project Increasing Irrigation Water Productivity in Mozambique, Tanzania and Zimbabwe through On-Farm Monitoring, Adaptive Management and Agricultural Innovation Platforms. The Australian government funds the project through the Australian International Food Security Research Centre of the Australian Centre for International Agricultural Research, with additional contributions from participating organisations. The Australian National University leads the project.

The Pathways to Resilience in Semi-arid Economies consortium, led by ODI, provided co-funding.

Contents

Acknowledgements	3
Tables, figures and boxes	7
Key Messages	9
Acronyms	11
Executive summary	13
1. Introduction	17
1.1 Renewed interest in irrigation	17
1.2 African experiences to date	17
1.3 This report	19
2. Methodology	20
2.1 Research approach and methods	20
2.2 Case study sites	20
2.3 Irrigation policy, practice and performance: Key concepts	23
3. Tanzania's irrigation sector	25
3.1 Country context	25
3.2 The irrigation sector, past and present	28
4. From policy to practice: Drivers of change and performance bottlenecks	40
4.1 Drivers of policy change	40
4.2 Bottlenecks to increasing irrigated agricultural productivity	41
4.3 Trade-offs: Winners and losers	45
4.4 Irrigation for climate resilience?	47
5. Conclusions and recommendations	49
5.1 In summary	49
5.2 Future pathways for irrigation policy and practice	49
References	53
Annex: Institutions consulted	58

Tables, figures and boxes

Table 1	Key features of the case study schemes	22
Table 2	Relevant actors in the irrigation sector in Tanzania	33
Table 3	Summary of key national policies relevant to irrigation	37
Figure 1	The Great Ruaha Catchment	21
Figure 2	Interactions between policy processes, irrigation practices and outcomes	24
Figure 3	Physical map of Tanzania	26
Box 1	Irrigation and climate change	18
Box 2	Challenges identified for Tanzania's irrigation sector	29
Box 3	Economic liberalisation – implications for the agriculture sector	31
Box 4	Tanzania's ambitious targets for agricultural development	34
Box 5	National Climate Change Strategy – strategic interventions relevant to agriculture	36
Box 6	Water scarcity and inefficient irrigation systems	44
Box 7	Gender, land and water	47

Key Messages

- Irrigation development is currently a key component of Tanzania's food security, rural poverty alleviation and climate resilience strategies. Yet achieving these outcomes is by no means guaranteed.
- Over the past 50 years, state investment in smallholder irrigation has waxed and waned, in a context of changing political agendas and macroeconomic conditions. Recent ambitious pledges to increase funding represent an exciting opportunity, provided there is appetite to learn from past mistakes.
- Although irrigation can be lucrative, many farmers report difficulties accessing inputs and markets, and for various reasons schemes repeatedly fall into disrepair. One underlying factor is an overemphasis on infrastructure, with limited attention to local capacities and institutions.
- In some parts of Tanzania, increasing competition for water has also resulted in conflicts among farmers and with other water users, raising wider questions about who benefits and who loses from irrigation expansion.
- In a country as diverse as Tanzania, tailored approaches will be essential to ensure public investments in irrigation support sustainable and equitable outcomes.

Acronyms

ACRP	Agriculture Climate Resilience Plan
AfDB	African Development Bank
AgWA	Partnership for Agricultural Water for Africa
ASDP	Agricultural Sector Development Programme
ASDS	Agricultural Sector Development Strategy
ASP	Afro-Shirazi Party of Zanzibar
BRN	Big Results Now
CAADP	Comprehensive Africa Agricultural Development Programme
CIA	Central Intelligence Agency
CCM	Chama cha Mapinduzi (Revolutionary Party)
DFID	Department for International Development
DIDF	District Irrigation Development Fund
DoE	Division of Environment
FAO	Food and Agriculture Organization
FANRPAN	Food Agriculture and Natural Resources Policy Analysis Network
FGD	Focus Group Discussion
GCAP	Global Climate Adaptation Partnership
GDP	Gross Domestic Product
GIZ	German Agency for International Cooperation
ICID	International Commission on Irrigation and Drainage
IDRC	International Development Research Centre
IFAD	International Fund for Agricultural Development
IFI	International Financial Institution
IMF	International Monetary Fund
IMT	Irrigation Management Transfer
INGO	International Non-Governmental Organisation
IO	Irrigation Organisation
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resources Management
JICA	Japanese International Cooperation Agency
LGA	Local Government Authority
MAFC	Ministry of Agriculture, Food Security and Cooperatives
MKILMA	Mkombilenga Ilo Ilo Mpya and Magozi
MWI	Ministry of Water and Irrigation
NAFSN	New Alliance for Food Security and Nutrition
NAFCO	National Agriculture and Food Corporation
NCCSC	National Climate Change Steering Committee

NCCTC	National Climate Change Technical Committee
NEMC	National Environmental Management Council
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organisation
NIDF	National Irrigation Development Fund
NIMP	National Irrigation Master Plan
NSGRP	National Strategy for Economic Growth and Reduction of Poverty (MKUKUTA)
ODI	Overseas Development Institute
PIM	Participatory Irrigation Management
PRISE	Pathways to Resilience in Semi-arid Economies
SAGCOT	Southern Agricultural Growth Corridor of Tanzania
TAFSIP	Tanzania Agriculture and Food Security Investment Plan
TANU	Tanganyika African National Union
UK	United Kingdom
UNDP	United Nations Development Programme
URT	United Republic of Tanzania
USAID	United States Agency for International Development
VPO	Vice-President's Office
WASH	Water, Sanitation and Hygiene
WRM	Water Resources Management
WUA	Water User Association
WWF	Worldwide Fund for Nature

Executive summary

Amid global concerns over rising food and fuel prices, changing diets and climate change, irrigated agriculture has an important role to play in increasing food production in an uncertain and resource-constrained world. For many countries in sub-Saharan Africa, it is also a key part of strategies to boost economic growth and tackle rural poverty. However, scepticism remains in some quarters, given the disappointments of past irrigation investments, concerns over land and water grabs and a lack of sufficient evidence regarding what works, why and where, and who benefits. We argue that we must pay attention to the history and politics of irrigation development if we are to understand the way policies and practices have evolved over time, and what the outcomes have been.

This report presents the findings of a rapid review to determine the policies and politics that have shaped irrigation practice and performance in Tanzania over the past 40–50 years. The review seeks to understand drivers (and blockages) of change with respect to improving sector performance and to identify opportunities for innovation. We also consider who has benefited and lost from public investments, and how these investments could better contribute to poverty reduction, economic growth and climate resilience. The focus of the analysis is small-scale irrigation schemes managed by farmers and supported by the state. We are particularly interested in the role irrigation plays in contexts characterised by high rainfall variability and increasing (physical or economic) water scarcity, such as the upper Rufiji Basin. The desk-based review was supplemented with in-country interviews at national and district level (Iringa), and brief site visits to three schemes in the Ruaha sub-catchment of the Rufiji (also Iringa district).

Tanzania has a long history of traditional, or informal, irrigation constructed by smallholder farmers and managed through customary arrangements. Since the 1970s there has also been interest from the state and international donors in investing in farmer-managed irrigation, particularly to introduce modern infrastructure and formal institutions. Meanwhile, investment in large-scale commercial production has waxed and waned. At present, the government is pursuing an ambitious target to expand the irrigated areas by 1 million ha by 2016, and the irrigation sector is receiving unprecedented political profile. Consequently, investments are on the increase. After decades of neglect, this turn of events presents an exciting opportunity.

Tanzania has made significant progress in increasing national food security over the past 20 years, largely because of irrigation expansion. Nonetheless, rural poverty remains endemic and economic growth has failed to translate to social benefits. The irrigation sector itself faces a number of challenges that limit its potential to contribute to national policy objectives, such as growth and poverty reduction. These challenges are complex – the result of various technical, political and institutional factors and drivers of change, operating at multiple scales. It is important to understand these dynamics and how they shape irrigation policy, practice and performance in order to chart plausible pathways for future sector development.

In Tanzania, irrigation policies and practices have been shaped by political and ideological changes (from colonial rule to socialism, then

neoliberalism); a belief in the need to modernise smallholder production; macroeconomic crisis and the internal and external factors that contributed to this, including drought and global oil prices; political interests in winning votes and maintaining coalitions, which for example have served to shape import and export policies for agricultural goods; and growing interest from international players, including donors and private investors. While climate change has not featured strongly in the political discourse surrounding irrigation *per se*, irrigation development is frequently viewed as the ‘solution’ to building resilience in the agriculture sector.

Key bottlenecks to policy implementation and performance relate to:

- Lack of political incentives to ensure stated objectives are met, weak accountability and the potential for patronage, at both national and local levels;
- A proliferation of institutions responsible for irrigation development, which hinders effective coordination, transparency and efficiency;
- A severe lack of capacity for implementation, particularly in district offices (to which responsibilities have been devolved), but also in the private sector (responsible for constructing schemes);
- The emphasis on building infrastructure, without due attention to and investment in farmer institutions for scheme management, operation and maintenance;
- Increasing competition over water, exacerbated by the absence of integrated planning or coordination among key sectors; basin water boards, which are responsible for overseeing this, are poorly resourced and politically weak.

Numerous problems are also manifest at scheme level. Common issues reported in our case study sites, and echoed by other authors, include badly designed/built infrastructure; difficulties adapting institutions for water management and enforcing rules; limited finance for maintenance and repairs; costly inputs set against unreliable markets and low prices; and vulnerability to seasonal floods or water shortages. In future, climate change could exacerbate existing pressures on increasingly scarce resources and lead to more frequent extreme events, damaging infrastructure and/or reducing crop yields.

Irrigation technologies are not the only answer to increase productivity, raise rural incomes or achieve growth in the agriculture sector. Nor is irrigation expansion a sure win for climate resilience. Improving performance in Tanzania’s irrigation sector will require a range of solutions at different scales. Some of these will be technical or managerial in nature, but many relate to the political or institutional environment and are likely to be more challenging to implement. Our suggestions include:

- *Managing water across scales:* Increasing competition for water and the threat of climate change requires new approaches to scheme design and management to build in greater flexibility, as well as greater attention to resource management and regulation at catchment level. Strengthening of formal integrated water resources management institutions could be complemented with issue-based approaches fostering collective understandings of specific (context-specific) problems and solutions.
- *Attention to local institutions for scheme management:* Blueprint approaches should be replaced with tailored interventions that build on existing capacities and institutions, such that exist, and are

adaptable as things evolve. This in turn requires different kinds of expertise, which may not currently be available in the sector, as well as adequate provisions in project budgets and timelines.

- *Irrigation must be profitable:* Unless the state is willing and able to subsidise repairs, irrigated agriculture needs to be lucrative for farmers. Market access is crucial in this regard, and the state has an important role to play in improving road networks, storage facilities and information systems, alongside policies to regulate market and input prices.
- *Ensuring benefits reach the poor and marginalised:* Irrigation development does not benefit everyone equally and can reinforce existing social inequalities. More research is needed to understand the nature of these effects and trade-offs, and how more equitable outcomes might be achieved. Additional support to disadvantaged groups may be necessary to overcome entry barriers, such as access to land or financial resources to pay for inputs.
- *Improving accountability:* Political will and patronage are difficult to tackle, but putting in place a strong framework for monitoring outcomes (as opposed to the current focus on activities or outputs) may help shine a light on problem areas and ensure sensible investment decisions are made. This information could also be used to identify capacity gaps and training needs.

1. Introduction

1.1 Renewed interest in irrigation

Amid global concerns over rising food and fuel prices, changing diets and climate change, agriculture has reappeared on the development agenda. Irrigated agriculture, in particular, is thought to have an important role to play in increasing the production of food in an uncertain and resource-constrained world. For many countries in sub-Saharan Africa, such as Tanzania and Zimbabwe, it is also a key part of strategies to boost economic growth and tackle rural poverty.

In 2005, the Commission for Africa called for a doubling of irrigation coverage on the continent within 10 years. Momentum has since gathered pace, evident in regional initiatives such as the Partnership for Agricultural Water for Africa (AgWA),¹ the Comprehensive Agriculture Development Programme (CAADP)² and the New Alliance for Food Security and Nutrition (NAFSN). However, scepticism remains in some quarters, given the disappointments of past irrigation investments, concerns over land and water grabs and a lack of sufficient evidence regarding what works, why and where, and who benefits.

This report is based on the premise that we must pay attention to the history and politics of irrigation development if we are to understand the way policies and practices have evolved over time, and what the outcomes have been. We seek to shed light on why the sector continues to underperform and how, in future, it may better

¹ AgWa provides support to the CAADP process and other agricultural water management initiatives in Africa.

² Under the New Partnership for Africa's Development (NEPAD).

contribute to equitable and transformative economic growth and climate resilience. While we recognise that technical and managerial aspects are important for performance, our focus in this report is on policy, institutions and the political economy of irrigation development.

1.2 African experiences to date

Irrigation has played an important role in agricultural modernisation around the world. However, outside of North Africa, irrigation is little practised on the African continent in comparison with in other regions (Neumann et al., 2011). In 2006, African countries collectively irrigated just 5.4% of their cultivated land, compared with a global average of around 20% and almost 40% in Asia (FAO, 2011). Nonetheless, the equipped area could increase substantially over the next 30–40 years as the sector is seeing increasing investment from both public and private actors. Frenken (2005) estimates that Africa has the potential to irrigate over 40 million ha in total, based on available land and water resources. However, such figures should be treated with caution. Country estimates of irrigation coverage and potential, on which regional estimates are based, can vary considerably depending on the methods used. For example, some estimates of irrigation potential are based on land resources alone, and, even where water resources are accounted for, this does not necessarily factor in the impacts of irrigation development on river flows or groundwater. There are also considerable gaps in the data for certain variables, such as type of irrigation used or area actually being irrigated as opposed to equipped (ibid.).

Throughout Africa's history, discourses relating to the use of land and water resources, the expected contribution of agriculture to national development and the respective role of the irrigation sector have evolved (Oates et al., 2015). Research in Ethiopia, Morocco and Mozambique shows that changes in policy have been driven to differing extents by political and ideological shifts, donor agendas and political projects, among other factors, and objectives have often been incoherent. These changes in irrigation policy have been mirrored in the fates of particular schemes.

Efforts to boost agricultural production in Africa began as far back as the 1920s under colonial administrations, and included large-scale irrigation developments in Sudan and Niger (Woodhouse and Ganho, 2011). Prior to this, irrigation had been practised on a relatively small scale,³ using traditional technologies and managed through customary institutions.⁴ Whilst traditional practices have evolved over decades and are (on the whole) relatively well adapted to local conditions, performance problems have plagued public investments in irrigation (both large and small) from the start.⁵ In part because of the disappointments of centrally

³ An important exception being the Nile in Egypt.

⁴ Traditional practices include, for example, the diversion of water from streams or rivers using earthen canals (e.g. in the Kilimanjaro Mountains of Tanzania) and the trapping of floodwater in shallow basins (e.g. along the Nile in Egypt).

⁵ Challenges include inappropriate design for local conditions, poor construction and/or maintenance, unreliable water supplies, ineffective institutions for collective scheme management, a lack of access to inputs or markets and high costs set against low profitability, among other factors (see Faurès et al., 2007; Merrey et al., 2007; Oates et al., 2015). Note that many of the problems encountered with large-scale irrigation are not unique to Africa but are also found in parts of Asia.

managed large-scale irrigation, irrigation management transfer (IMT) and the closely related concept of participatory irrigation management (PIM) became popular instruments for reform in the 1970–80s (Howarth et al., 2007; Merrey et al., 2007). Following structural adjustment in the 1980s and 1990s, many African countries actively sought to encourage private sector investment, including agri-businesses (see Oates et al., 2015 for a more detailed history).

For many developing countries, irrigation will continue to represent a substantial share of agricultural

investment in the near future (Faurès et al., 2007). Nevertheless, enduring challenges remain in managing irrigation to increase agricultural output, ensure sustainability and contribute to national development objectives. Although positive examples do exist, they tend to be isolated and context-specific (Wiggins and Leturque, 2010). Meanwhile, growth in the private sector has raised important questions around rights and regulation, the role of the state and who benefits from the development of land and water resources (Calow and Mason,

2014). In addition to technical or managerial interventions, Oates et al. (2015) point to the need to account for water at multiple levels, improve monitoring and sector coordination and manage trade-offs transparently. Climate change places an additional strain on sustainable land and water management and food production. New policies and deeper-seated structural changes will likely be necessary to address these challenges (Kadigi et al., 2012; Pavelic et al., 2013; Chiroro, 2015) (Box 1).

Box 1: Irrigation and climate change

Irrigation is increasingly viewed as a strategy to mitigate the impacts of climate variability and change. Large-scale irrigation schemes have the potential to buffer farmers from dependence on food aid in times of crop failure and drought (Deressa et al., 2009). Small-scale irrigation is seen as key to improving agricultural productivity and incrementally increasing the resilience of rural livelihoods (Sakaki and Koga, 2011; The Montpellier Panel, 2012; Chiroro, 2015).

At the same time, climate change will have a large impact on the potential for irrigation expansion (You et al., 2011). It is therefore essential that climate change concerns be incorporated in the design and management of irrigation schemes (Kurukuklasuriya et al. 2006; Davis and Hirji, 2011; Tubiello and van der Velde, 2012; Chiroro, 2015). Focusing on arid and semi-arid regions in particular, the literature suggests several ways to do this, including through technical models and predictions for climate change effects on irrigation systems (Fischer et al., 2007; Mendelson and Seo, 2007), and by increasing the efficiency of irrigation systems in terms of water management, timing, weather patterns, etc. (Pereira et al., 2002; Issar and Adar, 2010; Zhou et al., 2010).

It is thought that small-scale irrigation as an adaptation method is more likely to be successful if there are concomitant policies to provide local farmers with information on changing risks and alternative production techniques. Policies also need to facilitate access to the financial means to adapt the physical systems (Deressa et al., 2009; Lankford, 2009; Sakaki and Koga, 2011). When addressing the vulnerabilities of poor farmers, it is also important to consider existing coping strategies, human relationships and social norms (Sakaki and Koga, 2011). Ziervogel et al. (2006) similarly argue that climate change adaptation has a social and political dimension, and is not solely governed by environmental or economic concerns, which can determine options and outcomes.

Despite these useful insights, there has been surprisingly little critical reflection in the literature on the limitations of irrigation as an adaptation strategy in different contexts, or the potential for maladaptation. More needs to be done to understand the implications of current policy decisions for resilience and the trade-offs involved. Moreover, a noticeable gap is the theorising and testing of concepts such as adaptive capacity or resilience as they relate to irrigation.

1.3 This report

This report presents the findings of a rapid review to determine the policies and politics that have shaped irrigation practice and performance in Tanzania over the past 40–50 years. It is one of two studies commissioned by the Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN)⁶ with additional funding from Pathways to Resilience in Semiarid Economies (PRISE),⁷ building on previous work conducted by the Overseas Development Institute (ODI) (see Oates et al., 2015). The companion study looks at the irrigation sector in Zimbabwe (Mosello et al., 2016).

The objective of the research is to identify opportunities for innovation in irrigation policy and practice, with a view to charting more sustainable and resilient pathways for future irrigation development. We combine a review of the literature

⁶ <http://www.fanrpan.org/>

⁷ <http://prise.odi.org/>

with in-country interviews and short site visits, guided by the following questions:

- How has the irrigation sector evolved over time?
- What have been the drivers of change?
- Why has performance been disappointing?
- Who has benefited and who has lost from irrigation investments?
- How could irrigation development better contribute to poverty reduction, economic growth and climate resilience?

The focus is primarily on small-scale irrigation schemes managed by farmers and supported by the state, although we also touch on other governance arrangements. We are particularly interested in the role irrigation plays in contexts characterised by high rainfall variability and increasing water scarcity, whether this be physical (such as arid or semi-arid areas of

Zimbabwe) or economic scarcity (as in the Rufiji River Basin, Tanzania).

This report is structured as follows. In the next section we outline our approach and methodology, introduce the Tanzanian case study irrigation sites and discuss key concepts informing the review. Section 3 then provides an overview of the Tanzanian context, including key features of the irrigation sector, institutions or actors involved and national policies. It is in this section that we address the first research question, looking at how irrigation policy and practice have evolved over time. Section 4 tackles the remaining research questions, by seeking to understand the drivers of policy change, why performance bottlenecks persist and the implications for sustainability, equity and climate resilience. In our conclusions (Section 5) we draw a number of lessons for policy and practice.

2. Methodology

2.1 Research approach and methods

This review was commissioned as part of FANRPAN's project on Increasing Irrigation Water Productivity in Mozambique, Tanzania and Zimbabwe through On-Farm Monitoring, Adaptive Management and Agricultural Innovation Platforms. This collaborative project is led by the Australian National University and funded by the Australian Government via the Australian International Food Security Research Centre of the Australian Centre for International Agricultural Research, with additional contributions from participating organisations.

The review was co-funded by the PRISE consortium, led by ODI. PRISE research focuses on mechanisms of economic growth and social development, including institutional and regulatory frameworks, markets and bases of human and natural capital. The consortium is funded under the Collaborative Adaptation Research Initiative in African and Asia, with financial support from the UK Department for International Development (DFID) and the International Development Research Centre (IDRC).

Building on ODI's recent research *Pathways for irrigation development in Africa – insights from Ethiopia, Morocco and Mozambique* (Oates et al. 2015), this study looks at past (40–50 years) and current trends in irrigation and related sector policies and institutional arrangements in Tanzania, towards identifying options for national and regional policy innovation. It aims at understanding the social and economic goals governments and donors are pursuing when investing

in irrigation, which options are being privileged and why (e.g. small- versus large-scale schemes) and whether they actually support or deliver on the intended goals. Besides improving water management and productivity, which is the focus of the Australian-funded project, we are interested more broadly in how irrigated agriculture can best support sustainable and resilient development, and what the benefits, trade-offs and equity implications of policy choices might be.

Guided by the research questions outlined above, we first undertook a rapid review of the country-specific literature to understand the policy and institutional framework for irrigation development, and the factors (external or internal) that have shaped the sector's evolution over the past 40–50 years. The review focused primarily on the national picture but also considered international, regional and local dynamics and trends, where relevant. It included, *inter alia*, key policy and strategy documents, political economy studies, case studies and assessments of sector performance.

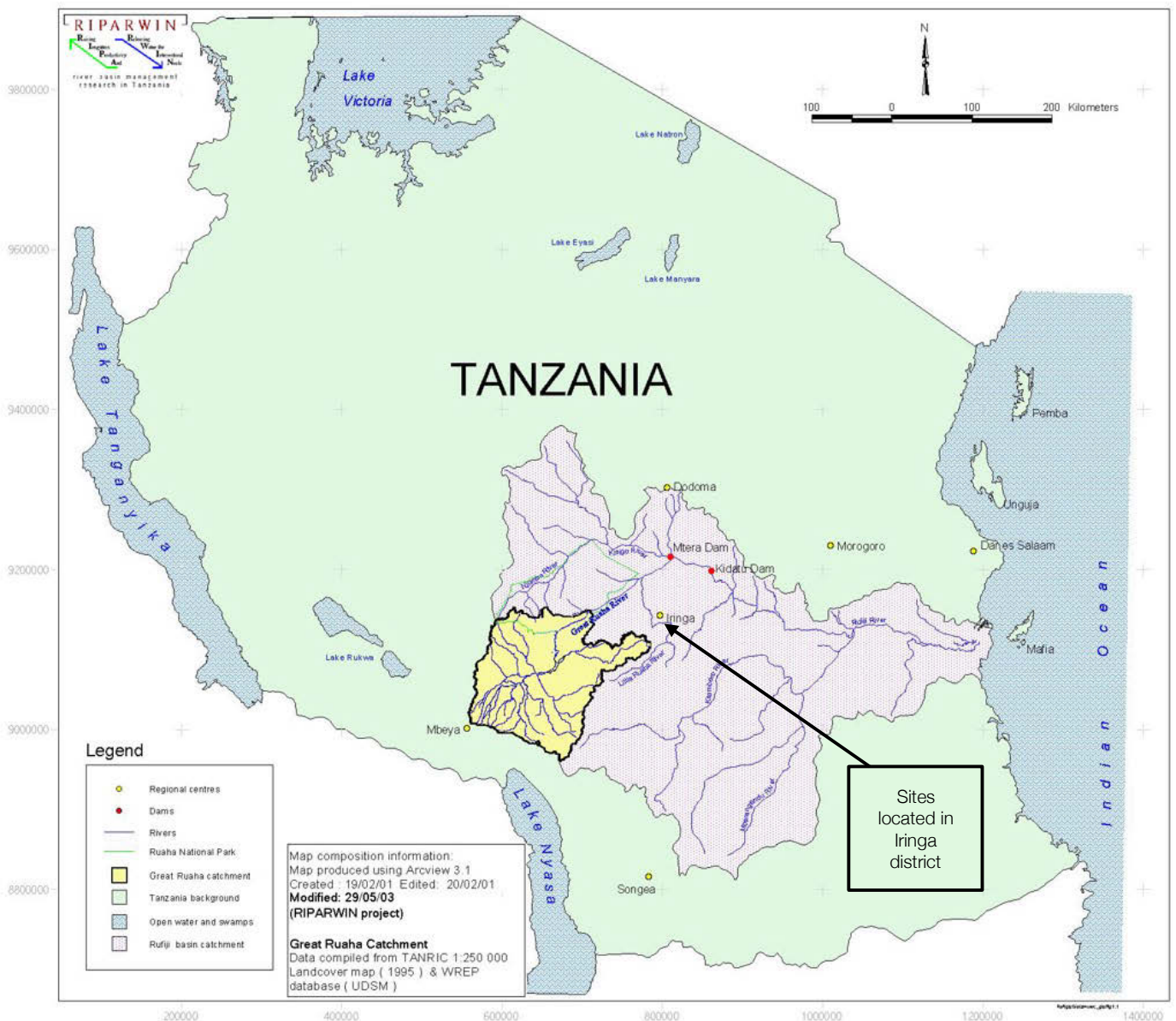
The desk-based review was supplemented by in-country consultations with experts based in Dar es Salaam and Iringa, as well as brief visits to three smallholder irrigation sites located near to Iringa. A total of 14 interviews and 3 focus group discussions (FGDs) were held during this 10-day visit in April–May 2016. Interviewees were selected based on their knowledge, experience and availability. At national level, this included experts in the agriculture, water and environment sectors, from government institutions, academia, donor organisations and international non-governmental

organisations (INGOs). At subnational level we consulted representatives from the Rufiji Basin Water Board, the agricultural office in Iringa district and a locally active INGO, as well as members of the irrigation associations (Annex 1 presents a list of the institutions consulted). Further insights were gleaned from informal conversations with various stakeholders at a Worldwide Fund for Nature (WWF) symposium in Dar es Salaam (5–6 May 2016), and with UK-based experts.

2.2 Case study sites

The three irrigation sites we visited are located in Tanzania's Southern Highlands, Iringa district, falling within the Great Ruaha catchment of the Rufiji River Basin (see Figure 1). The Rufiji Basin is the largest in Tanzania, covering about 20% of the country's land area. It is managed by the Rufiji Basin Water Board, whose main office is located in Iringa. The Great Ruaha is the largest sub-catchment of the Rufiji, occupying 47% of the basin and contributing 15% of the water (Mwalyosi, 1990; Interview H). The main sources of livelihoods in the Great Ruaha area are irrigation, rain-fed agriculture, fishing and livestock-keeping. The river is also an important source of hydropower (Mtera and Kidatu Dams) and supports the Ruaha National Park. Decreased flows in the Great Ruaha have been recorded since the early 1990s and the river has become seasonal (Franks et al., 2004). This has been attributed to over-abstraction and poor water management in the upper catchment, among other factors (Baur et al., 2000; Lankford and Franks, 2000).

Figure 1: The Great Ruaha Catchment



Note: The area demarcated in yellow shows the upper part of the Great Ruaha catchment only. Our sites are located in the lower part of the catchment, in Iringa District.

Source: Reproduced from the RIPARWIN project with permission.

Irrigation coverage in the Rufiji Basin varies from 25,000 to 55,000 ha, depending on the season, representing about 15% of Tanzania's total irrigated area (Patel et al., 2014). In Iringa district, the main irrigated crops are paddy rice, maize and vegetables such as tomatoes and onions, grown for both subsistence needs and sale. Problems of food insecurity have led the District Council to give emphasis to irrigation development, and in 2005/06 the local

government started working on improving smallholder irrigation schemes (Interview G). To date, 21,700 ha of irrigation have been developed according to the Iringa District Plan (2016/17), although this figure is unlikely to capture informal irrigation.

Table 1 provides a summary of the key features of our three case study irrigation sites. Kiwere and Magozi are gravity-based canal systems abstracting water from the Little

Ruaha River, whereas Igingilanyi uses groundwater for drip irrigation. The farmers at Magozi have a permit to irrigate only once a year, growing paddy rice, whereas farmers at the other two schemes can grow horticultural crops year round. All three schemes have been funded by external actors and are managed by farmers with limited external support. In Kiwere, a handful of farmers practised some informal irrigation prior to intervention.

Table 1: Key features of the case study schemes

	Kiwere	Magozi	Igingilanyi
Date irrigation began	2007	2007	2012
Location	Kiwere ward, Iringa district (20 km northwest of Iringa town)	Ilolompya ward, Iringa district (60 km northwest of Iringa town)	Kisinga ward, Iringa district (25 km north of Iringa town)
Water source	Little Ruaha River (diversion)	Little Ruaha River (diversion)	Groundwater/borehole (pumped using solar and wind energy; storage tank of 150,000 litres)
Irrigation system	Partially lined canal system (gravity)	Partially lined canal system (gravity)	Drip irrigation (piped)
Potential irrigation area	-	1,300 ha	20 ha
Current equipped area	280 ha	950 ha	6 ha
Actual irrigated area	280 ha	950 ha	6 ha
Construction	195 ha	650 ha	6 ha
Management	Intake constructed with funding from Japan (2004–5; TZS 148 million); farmers contributed labour and local materials	Funding from Anglican Church, Participatory Agriculture Empowerment Project, District Council (2005–7; TZS 210 million); farmers contributed labour and local materials; additional funds to line canals from DIDF and JICA	DIDF (TZS 625 million)
Growing season	Tupendane Group Cooperative (168 members)	MKILMA irrigation association (503 members)	Igingilanyi Irrigation Organisation
Land tenure	Year round	November to July	Year round
Plot sizes	Mainly traditional inheritance, few instances of renting/buying land	Based on customary law, few instances of renting/buying land; the land was shared with newcomers when Ilolo village was relocated here	Village land; irrigated area shared among community members
Crops grown	Horticulture (e.g. tomatoes, eggplant, onions, beans, green maize)	Paddy rice	Horticulture (e.g. tomatoes, eggplant, onions, beans, green maize)
Opportunities	Good (physical) access to markets	Irrigated production helps reduce food insecurity in this drought-prone area	Good (physical) access to markets
Key issues	<ul style="list-style-type: none"> Lack of access to water in large parts of the scheme Limited extension support Poor information flow between farmers Variable market prices and trading arrangements 	<ul style="list-style-type: none"> Siltation of canals owing to poor intake design Flooding in parts of the command area Poor access to water in other parts of the scheme especially downstream Poor access roads within the scheme Limited extension support Low membership of association Conflicts between farmers and livestock-keepers 	<ul style="list-style-type: none"> Lack of access to water in large parts of the scheme Limited extension support Poor information flow between farmers Variable market prices and trading arrangements

Source: Summarised from Mdemu and Mziray (2014), supplemented by the authors' interview data

2.3 Irrigation policy, practice and performance: Key concepts

Irrigation performance can be understood and measured in different ways, and approaches to conceptualising indicators have implications for performance evaluations. Despite efforts to standardise some of these key indicators, researchers and practitioners continue to use a variety of methods to assess performance, making comparisons difficult (Lankford, 2012). In recent years, the field has also encompassed new criteria and perspectives, which can lead to conceptual confusion in evaluating irrigation performance (Chaponnière et al., 2012).

A distinction can be made between efforts to evaluate the technical performance of irrigation and those evaluating the outcomes of irrigation investments. The former is concerned with monitoring and measuring the function and direct outputs of irrigation investments. The latter is concerned with evaluating the contribution of irrigation investments to outcomes and policy objectives such as food security, poverty reduction and generation of exports.

Irrigation schemes can experience problems in technical performance owing to a range of factors. These include poor planning and design, declining soil fertility and productivity, financial unsustainability and deficits in operations and maintenance. Technical performance indicators, such as on yields, coverage, cost recovery and supply interruptions, provide entry points for identifying problems in performance (see Boss et al., 2005 for a comprehensive list of technical performance indicators).

Causal linkages between scheme technical performance and outcomes are more complex and

remain under-researched (Chaponnière et al., 2012). Poor technical performance can certainly undermine the achievement of intended outcomes. However, outcomes are conditioned by many other drivers and influences, making the attribution of outcomes to technical performance problematic (Forss et al., 2011). For example, observed poverty reduction may result from direct effects such as increased agricultural output, or indirect effects such as improved transportation infrastructure, or combinations of direct and indirect effects (Smith, 2004). Similarly, despite high technical performance, poverty levels may not fall if necessary off-scheme components of success, such as market access, are not in place. Despite the difficulties in measuring and attributing the contribution of irrigation schemes to policy objectives, these linkages can be evaluated qualitatively.

A distinction can be made between outcomes for scheme beneficiaries, such as improvements in farmer income, and outcomes for wider society, such as the generation of tax receipts. Irrigation schemes can potentially contribute to multiple policy objectives and outcomes, for both on-scheme and off-scheme beneficiaries. Rather than attempting to compare them directly, these outcomes and policy objectives can be framed in terms of economic growth, sustainability and social equity.

In this framing, economic growth encompasses income generation, employment, economic and livelihood diversification and the generation of exports and taxes. Sustainability addresses questions of the scheme's water demand and impact on water resources, its vulnerability to drought and the potential impacts of climate change and other issues of long-term financial, environmental and technical viability. Questions of

equity consider the extent to which and how the costs and benefits of the scheme are shared between farmers on the scheme, and between the scheme beneficiaries and broader society. An irrigation scheme may positively, negatively or not affect each of these issues, and setting objectives for irrigation policy and individual schemes usually involves making explicit or implicit trade-offs between these effects.

Technical performance and outcomes are closely related to how irrigation is practised. Irrigation practice is usually considered in terms of engineering and agronomic principles, technologies and techniques applied by scheme designers, managers and farmers. More broadly, the term can include consideration of scheme management and coordination, and other inputs associated with the irrigation scheme, such as technical assistance and access to agricultural inputs and markets. We conceptualise irrigation practice in terms of how irrigation investments are designed, implemented, managed and used on a day-to-day basis.

Technical performance and outcomes are significantly shaped by irrigation practice, although external factors such as market signals and environmental change are also influential. However, practice is not static, and evolves in response to experience, new knowledge and changing conditions. In particular, irrigation practice evolves in response to assessments of technical performance and achievement of objectives and outcomes.

Irrigation practice is also shaped by policy and embedded within a political context. Political discourse, for example on poverty reduction or economic growth, shapes agricultural and irrigation policy. In turn, development and economic policies influence investments and set objectives for irrigation practice

to achieve. Policy processes are rarely linear, and policy, investments, politics and practice all can influence each other (Figure 2) (see also Oates et al., 2015).

These political and policy contexts have consequences for irrigation practice. Setting objectives prioritises particular outcomes, and these shape decisions in scheme design, implementation and management. These choices can result in trade-offs between outcomes (e.g. high yields versus long-term sustainability) and the costs and benefits of irrigation to different groups (e.g. upstream

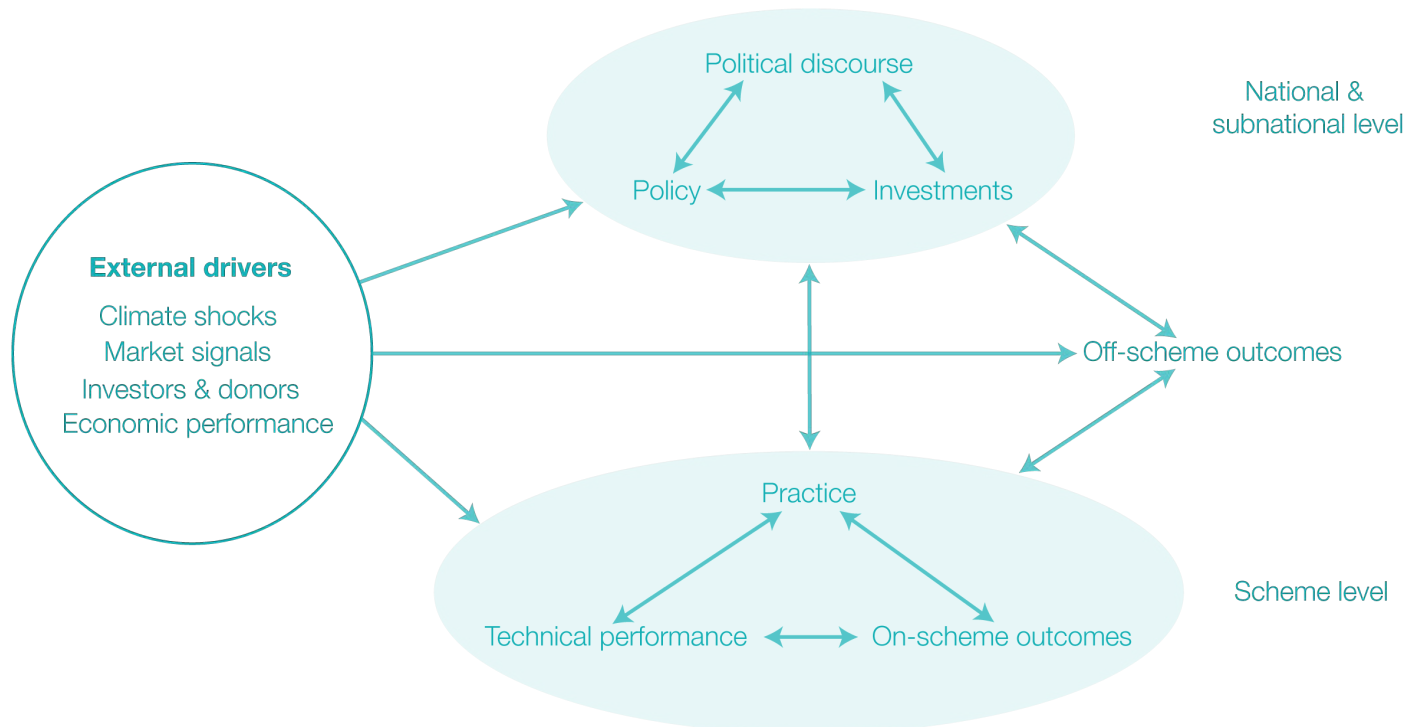
versus downstream users). The extent to which – and how – political and institutional factors shape these trade-offs, and the creation of winners and losers, is a question of political economy.

Political economy analysis asks how actors operate within institutional rules and incentives to achieve their own objectives (e.g. Harris, 2013). Applied to issues of irrigation, it provides a framework for assessing how politics and specific interests shape technical performance and outcomes, the trade-offs between them and the

costs and benefits to different actors.

However, irrigation does not have to be a zero-sum game. By framing trade-offs and the distributions of costs and benefits between outcomes and groups as following from choices and practices shaped by policies and in turn by politics, we aim to identify lessons for strengthening irrigation performance against a range of criteria, and to improve public welfare.

Figure 2: Interactions between policy processes, irrigation practices and outcomes



Source: Authors.

3. Tanzania's irrigation sector

3.1 Country context

To contextualise later discussions, this section provides an overview of the climatic, socioeconomic and political situation in Tanzania, before moving on to describe the salient features of Tanzania's irrigation sector, including its history, current policies and institutions.

Climate and agro-ecology

The United Republic of Tanzania (URT) is an East African country, consisting of the mainland (previously Tanganyika) and Zanzibar (see Figure 3). Tanzania has nine major drainage basins, the largest of which is the Rufiji. Total renewable water resources are estimated at 93 km³ per year (FAO, 2005) or 3,300 m³ per capita (URT, 2011a); groundwater resource endowment is estimated at 5,250 km³ (MacDonald et al., 2012). Although this appears generous, availability of, and access to, water resources is uneven across space and time, and concerns over scarcity are growing as economic and domestic demands increase (GCAP, 2011).

Lying just south of the equator, Tanzania is a tropical country with a variable and complex climate and agro-ecology. The northern and eastern parts of country have two rainy seasons – the short rains in October to December (*Vuli*) and long rains in March to May (*Masika*). The rest of the country has a single rainy season from October to April–May (McSweeney et al., 2010; URT, 2014). Rainfall patterns have a strong influence on cropping patterns and livelihood zones (URT, 2014). Higher rainfall areas include the coastal plains, which are hot and humid, and the highlands of the north, south, southwest and far west, where crops are diverse. Low rainfall is experienced in the arid

and semi-arid interior of the country, areas that are largely pastoral and have a high dependence on drought-tolerant crops (SUA, 2014, cited in URT, 2014).

Climate variability and change pose a considerable challenge for Tanzania's development, particularly given the country's high level of dependency on rain-fed agriculture. Rainfall is already highly variable in terms of timing and volume and can be difficult to predict. Some regions are also vulnerable to extreme events such as floods and drought (McSweeney et al., 2010).⁸ According to the World Bank (2013), weather-related risks already cost the agriculture sector at least \$200 million per year. The 2005/06 drought alone affected millions of people and cost 1% of gross domestic product (GDP) (GCAP, 2011). Floods can have similar economic and social impacts.

Historical records show that Tanzania is getting hotter and precipitation patterns are shifting. Average temperatures have been increasing steadily since the 1960s, rising by 1°C from 1960 to 2006, and are expected to rise a further 1.5 to 4.5°C by the 2090s (McSweeney et al., 2010). Rainfall data show a decreasing trend nationally since the 1960s (*ibid.*), but future changes are more difficult to ascertain and projections vary widely between climate models (Wambura et al., 2014). On average, rainfall is expected to increase, especially in the wet season, with an increase in the proportion falling in heavy rainfall events (McSweeney et al., 2010). But not all areas will experience the same changes. Decreases in rainfall

⁸ Semi-arid regions are the most vulnerable to droughts (URT, 2014).

could be seen in some regions in future, particularly in unimodal climatic regimes (Matari et al., 2008, cited in URT, 2014), although there is considerable uncertainty here (Wambura et al., 2014). The magnitude and nature of changes will also vary between seasons.⁹

Given these trends and projections, there are concerns that in Tanzania:

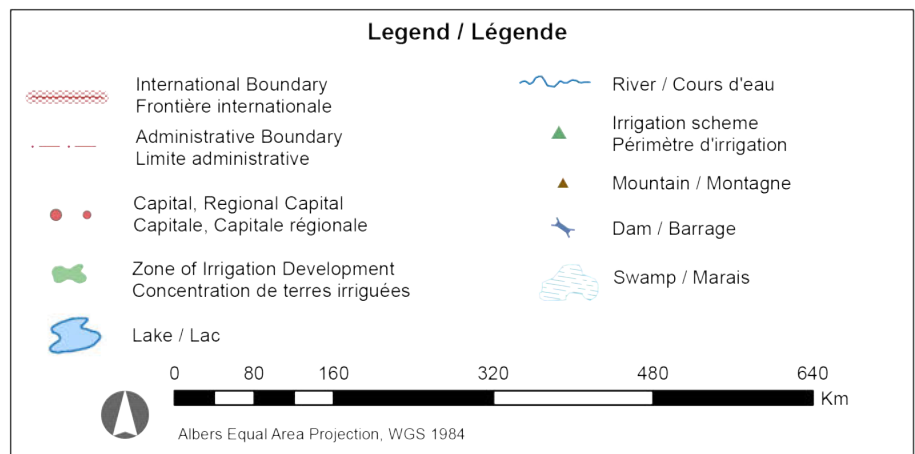
- *Seasonal shifts in temperature and rainfall* could modify crop growing seasons and lead to changes in agro-ecology.
- *Increasing unpredictability and variability in rainfall* could affect the timing and predictability of the onset of the rainy season and therefore crop planting decisions.
- *Heavier, more concentrated rainfall could damage crops and infrastructure*, negating the benefits of increases in rainfall for crop production.
- *Decreases in rainfall and increased risk of drought* could reduce water availability for crops. Droughts are already one of the highest risks to agriculture (URT, 2014).¹⁰

Mitigating climate risks is expensive. The Global Climate Adaptation Partnership (GCAP) (2011) estimates that meeting Tanzania's immediate needs for adaptive capacity will cost \$100–150 million per year, with medium-term costs in the order of \$250–1,000 million per year by 2030.

⁹ In Eastern and Southern Africa the tendency post-1980 has been for declines in rainfall in the main growing season, contributing to food insecurity (Funk et al., 2008).

¹⁰ For example, rice production has been shown to be negatively affected by stresses such as extreme temperatures, floods and droughts – factors that are expected to worsen with climate change (Manneh et al., 2007).

Figure 3: Physical map of Tanzania



UNITED REPUBLIC OF TANZANIA

FAO - AQUASTAT, 2015

Disclaimer
The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Source: FAO – AQUASTAT (2015), http://www.fao.org/nr/water/aquastat/countries_regions/tza/TZA-map_detailed.pdf.

Economic and social development

Tanzania is considered an emerging economy with high growth potential (URT, 2011b). With the support of development partners, the country has made important economic and structural reforms over the past decade (World Bank, 2016), and has maintained impressive growth rates over this period. GDP growth was 7.1% in 2015, and averaged 6.72% from 2002 to 2015 (Trading Economics, 2016). Growth has been particularly strong in construction, transport and financial services, with somewhat weaker performance in the agriculture sector, whose contribution to GDP has been declining (World Bank, 2016). Nonetheless, agriculture remains central to Tanzania's social and economic development. The sector generates 24% of GDP and 30% of exports, and is the predominant livelihood for around 75% of the population (URT, 2013b). In arid and semi-arid regions many households depend entirely on livestock and food crop production for their survival (World Bank, 2013).

Despite its potential, Tanzania remains one of the poorest countries in the world. Tanzania has a rating of 0.521 on the Human Development Index, placing it in the 'low human development' category (UNDP, 2015). Over 43% of the population lives below the income poverty line and 32% lives in severe poverty (ibid.). There has also been little progress in tackling food insecurity and malnutrition remains a key concern (URT, 2011b). Failure to translate growth in the economy to poverty reduction has been attributed to low investment in agriculture – 7% of public expenditures in 2015 (CIA, 2016) – as well as the predominance of subsistence production, low use of improved inputs and other constraints to increased agricultural productivity (URT, 2011b).

Tanzania's rapidly expanding population of over 50 million (UNDP, 2015) poses an additional challenge to the country's development. The population is highly dependent on the environment and natural resources, and managing land and water sustainably is becoming an increasing challenge. For example, agricultural expansion is a major driver of deforestation and land degradation in the country (URT, 2013a); it is estimated that 25% of Tanzanians live on degraded land (UNDP, 2015). Although predominantly rural at present, by 2050 the population is projected to be over 50% urban, with Dar es Salaam alone housing over 10 million people (GCAP, 2011). Changes in urban diets and rising incomes are affecting demand for agricultural products. Urban consumers are shifting away from traditional staples such as cassava and maize, preferring rice and wheat. Smallholder and commercial producers will need to adapt to these changes in demand (URT, 2014).

Politics and governance

The URT was formed in 1964 with the union of two newly independent states, Zanzibar and Tanganyika (CIA, 2016). A socialist period of rule followed under President Julius Nyerere. In 1977 an agreement was made to form a single ruling party, merging the Tanganyika African National Union (TANU) and the Afro-Shirazi Party (ASP) of Zanzibar. The new party, led by Nyerere, was called the Chama cha Mapinduzi (CCM) or Revolutionary Party. It was not until 1992 that Tanzania transitioned to multi-party democracy, with the first elections held three years later (World Bank, 2016).

Tanzania is distinguished by its diverse ethnicities and widespread use of a common language, Swahili, which 'facilitated the construction of an embracing national identity during the first decades of

independence' (Booth et al., 2014: 35). This feature has helped create political and social stability. According to the World Bank (2016), this stability 'has provided a solid foundation for Tanzania's growth, and with its economic prospects, has raised Tanzania's profile in the region and the world'. Nonetheless, the political union with Zanzibar has always been fragile, and the fall of CCM remains a possibility (Booth et al., 2014). Although CCM has so far retained its hold on power, elections have been closely fought and the results contended (CIA, 2016). Meanwhile, corruption is widespread, undermining service delivery and socioeconomic progress in general (Lufunyo, 2013).¹¹ While agricultural development retains a high profile in political debates, in practice the nature of the current political economy makes it difficult to enforce policies or pursue long-term strategies, and most aid to the sector has been ineffectual (Booth et al., 2014).

Another feature of the current political landscape is the growing influence of lower-level factions of government (Therkildsen, 2011). Administratively, Tanzania is divided into 30 regions (25 on the mainland and 5 in Zanzibar), which are further divided into districts governed by Local Government Authorities (LGAs). Tanzania has been implementing local government reforms since the end of the 1990s with a view to devolving political, financial and administrative powers to LGAs (Kuusi, 2009). While mainland government has retained overriding power within the framework of the Constitution, LGAs now have the authority to make by-laws, pass annual budgets and collect taxes within their area of jurisdiction (ibid.). They are responsible for delivering services to citizens and have direct

¹¹ For example, a highly publicised scandal in 2014 led to the freezing of direct budget support to government from donors (World Bank, 2016).

access to development funds, including for irrigation. Local actors have also increased their power through political connections. District and village-level governments are almost exclusively controlled by CCM and party leaders often use them to mobilise votes, giving local actors a degree of leverage over the ruling elite when it comes to enforcing policy decisions (Therkildsen, 2011).

3.2 The irrigation sector, past and present

It is often claimed that Tanzania could be the breadbasket of East Africa, given its generous endowment of natural resources and underexploited agricultural potential.¹² Since the 1990s, significant progress has been made in expanding the production of key crops such as maize and rice and hence reducing national food insecurity. However, it is only in the past decade that agricultural output has exceeded population growth, and productivity per hectare remains disappointingly low, despite considerable research and 'good practice' (Coulson and Diyamett, 2012). The dominant policy discourse attributes these problems to smallholder production systems, and promotes modernising and commercialising smallholder farming as the principle solution (e.g. URT, 2011b; 2013b). The main vehicle for achieving this contemporarily is the Agricultural Sector Development Programme (ASDP), described below. In parallel, there have been initiatives to attract private sector investment in agricultural production and value chains, the most notable being the

¹² The belief that Tanzania has enormous agricultural potential underpins much of the government's current policy. However, Coulson (2015) argues that the reality is somewhat different: Tanzania does not have large tracts of land readily available for agricultural expansion. The most fertile areas, and those that are well connected to markets, are already under cultivation. A large area has also been allocated to national parks. The remaining areas are mostly arid and semi-arid, better suited for livestock rather than crop production (ibid.).

Southern Agricultural Growth Corridor of Tanzania (SAGCOT).

Irrigation development is currently very prominent in Tanzania's major agricultural and poverty reduction policies and strategies, and cited as one of the key strategies for achieving food security and agricultural growth (Nkonya, 2013). In the National Irrigation Master Plan (NIMP), the area with *high potential* for irrigation development, based on available land and water resources, is estimated at 2.1 million ha (JICA, 2002).¹³ However, capacity to exploit this potential is thought to be limited (ibid.). Experts such as Coulson (2015) believe the potential for large-scale irrigation is modest at best. There is perhaps more scope for small-scale irrigation development, for example producing high value crops in dry periods of the year (see also Mdee, 2014).

The ASDP set an ambitious target to develop 1 million ha of irrigation by 2016. Although this target has not been met, expansion appears to have accelerated over the ASDP period, increasing from 264,000 ha in 2006 (Coulson and Diyamett, 2012) to around 460,000 ha in 2016 (Interview B; URT, 2014 gives a similar figure). It is unclear to what extent these numbers capture farmer-built schemes, however. Estimates for traditional irrigation vary from 118,000 ha (Table 2 below) to as much as 750,000 ha (Evans et al. 2012, data for 2008).¹⁴ In general, the pace of irrigation development has been slow in

¹³ The much higher figure of 30 million hectares from the Japan International Cooperation Agency (JICA) study, which is commonly cited in government documents, includes medium and low potential areas. Maps of irrigation potential can be found at http://open_jicareport.jica.go.jp/pdf/11705068_10.pdf

¹⁴ Traditional irrigation is defined as impermanent structures, initiated and operated by farmers. 'Developed', 'modern' or 'improved' irrigation schemes are formally planned and built by government or privately (AgWater, 2010; Nkonya, 2013). A number of authors have debunked the traditional versus modern dichotomy (e.g. Mdee, 2014; Oates et al., forthcoming).

Tanzania, suggesting it may not be as easy as often stated to bring new schemes into production. Much of the ASDP investment has been spent on rehabilitating or upgrading existing schemes.

Irrigated agriculture is concentrated mainly in the mountainous eastern and south-western regions of Tanzania, such as Kilimanjaro, Mbeya and Morogoro, where traditional irrigation has flourished, as well as Arusha and Iringa. It is less commonly found on the coastal plain or in arid and semi-arid areas, although subsistence farmers do practise some flood recession agriculture and water harvesting (AgWater, 2010; Nkonya, 2013). Most irrigated agriculture is small in scale and managed by farmers, although a few larger schemes have been developed, such as Dakawa (2,000 ha), Mbarali (3,000 ha) and Kilombero, the latter including a commercial rice farm owned by Kilombero Plantations Limited.¹⁵ The most common technology is surface (gravity) irrigation, whereby water is distributed through a canal system, furrows and basins. Sprinkler and drip irrigation are less prevalent and in the past were mainly found on commercial farms (FAO, 2005). However, drip does appear to be increasing in popularity (AgWater, 2010), including uptake by smallholders, for example in the Uluguru Mountains (Mdee, 2014).

The majority of irrigation relies on river water rather than groundwater. The main crops are cane sugar, paddy rice and maize.¹⁶ Other crops smallholders grow include vegetables, beans, bananas and cotton. Cane sugar, cashews, tea and coffee are grown as cash crops on private irrigation farms

¹⁵ The Tanzanian government uses the following size classifications for irrigation schemes: large-scale (over 2,000 ha), medium (500–2,000 ha) and small-scale (under 500 ha).

¹⁶ In 2002 these two crops accounted for about 48% (rice) and 31% (maize) of the irrigated areas, whereas other crops account for the remaining 44% (cropping intensity being 123%) (ICID, 2012).

(ICID, 2012); with the exception of tea these are all-water intensive crops. Cane sugar is also grown by out-growers linked to such farms.

Ensuring irrigation is both efficient and sustainable remains a critical challenge for the sector (Mdee, 2014). Traditional agriculture, including irrigated production, is under increasing pressure as a

result of population growth and land degradation, a feature of which has been a move away from fallow systems to permanent cropping (URT, 2013a). Meanwhile, efforts to develop modern irrigation have been capital-intensive and the results disappointing. Many larger schemes have been unable to operate at their full potential and a number of key problems persist,

such as lack of investment in maintenance and ineffective institutions for scheme management (Box 2; see Mdee, 2014 on Dakawa). On the positive side, more resources are available for irrigation development following renewed interest from government and donors.

Box 2: Challenges identified for Tanzania's irrigation sector

According to the NIMP (JICA, 2002), Tanzania's irrigation sector suffers from:

- A lack of appropriate participatory approaches;
- Unsound logic in project design and weak linkages between purpose and outputs of projects;
- Misunderstanding of the concept of 'simple and low-cost technology';
- A lack of feedback systems on the lessons learnt from implementing irrigation projects;
- Inadequate guidelines and manuals for planning, design and construction supervision (which are also not used);
- The need for a more effective support system to water user associations'/irrigation groups' activities;
- A lack of human resources and active participation of LGAs in irrigation development.

Interestingly, there is no explicit mention here of water resources *per se*, indicating that water availability is not perceived as a key constraint.

Source: Adapted from ICID (2012).

Historical overview

In order to understand government policies and priorities today, it is important to understand the history of irrigation development in Tanzania and the political and economic influences that have shaped the sector. Tanzania is a diverse country, in terms of climate, agro-ecology and farming systems, as well as social and economic institutions. This makes it difficult to generalise, and demonstrates the need for policies and approaches that can be adapted to context.

In some parts of Tanzania, farmers have been practising irrigation for centuries, long before the state decided to intervene (e.g. Gray, 1963 on the Sonjo; Yoshida, 1985 on the Pare). Small-scale irrigation flourished in a number of regions,

including Arusha, Iringa, Tanga, Mwanza, Shinyanga, Kilimanjaro, Mbeya, Morogoro and Ruvuma (see Kissawike, 2008). Farmers used a variety of simple methods adapted to local conditions, one of the most developed examples being the use of furrow systems to convey water on mountain slopes around Mount Kilimanjaro (Tagseth, 2008), growing crops for subsistence. Resources were managed under informal and customary rights (Charnley, 1991, cited in Patel et al., 2014). Modern irrigation was introduced much later, in the 1930s, by the foreign-owned Tanganyika Planting Company, which grew sugar cane near Moshi town (Chiza, 2005, cited in Therkildsen, 2011). Other commercial farms and estates were

also established under the colonial regime. For example, in 1948, the colonial administration invested in a 1,000 ha rice farm at Kilangali, Morogoro (ibid.).¹⁷

Following independence, in the 1960s Tanzania saw a boom in donor- and state-funded development of large-scale irrigation, which lasted until the 1980s. Tens of millions of dollars were invested in state farms during this period, including schemes such as Dakawa (rice), Mbarali (rice) and Kilombero (sugar). These investments were considered essential for achieving food self-sufficiency, increasing rural employment and reducing

¹⁷ The initiative failed and was abandoned in 1951.

Tanzania's dependency on exports, particularly rice (JICA, 2002). By 1980, large irrigated farms were cultivating a total of 24,000 ha, or 16% of the total land irrigated at that time (Isinika, 2003, cited in Therkildsen, 2011).¹⁸ The National Agriculture and Food Corporation (NAFCO) and other parastatal organisations were managing most of these. Smallholder irrigation was largely left to local initiatives and assigned few public resources (Chiza, 2005, cited in Therkildsen, 2011).

Many large-scale irrigation projects either failed completely or never reached their planned potential (JICA, 2002; Mdee, 2014 on Dakawa). In part because of these disappointments, donor interest shifted in the late 1980s and 1990s to supporting smallholder irrigation, including large World Bank and DFID-funded projects in the Rufiji Basin.¹⁹ Responsibilities for managing small water supplies and irrigation schemes were devolved to village councils and water user association (WUAs), while larger structures remained under central authorities (Maganga et al. 2002; Kissawike, 2008, both cited in Patel et al., 2014). Nonetheless, farmers remained heavily reliant on government to maintain or rehabilitate infrastructure (Patel et al., 2014). This was also a time when public funding for agriculture declined and large-scale irrigation infrastructure fell into disrepair (Coulson and Diyamett, 2012). For example, Dakawa rice farm was built in 1981 and managed by

¹⁸ Traditional irrigation accounted for 84 percent of irrigated land in 1980, although this may be an underestimate (Isinika, 2003, cited in Therkildsen, 2011).

¹⁹ Around the same time, the concept of integrated water resources management (IWRM) was gaining ground. In 1996 the World Bank funded the River Basin Management and Smallholder Irrigation Improvement project, to improve the efficiency of selected traditional schemes, among other objectives (Lankford et al., 2004). Meanwhile, DFID developed a project for Sustainable Management of the Usangu Wetland and its Catchment followed by Raising Irrigation Productivity and Releasing Water for Intersectoral Needs (ibid.).

NAFCO, which collapsed in 1996. The farm had reportedly been unused for 10 years prior to this, and has since been rehabilitated at considerable expense (Mdee, 2014).

Macroeconomic changes have strongly influenced the evolution of agricultural policy in Tanzania (URT, 2013b). National policies in the 1960s and 1970s were built on a version of African Socialism, known as Ujamaa (meaning brotherhood, or family-hood), developed by President Nyerere. The principles of Ujamaa are embodied in the Arusha Declaration and Socialism for Rural Development document of 1967, which was in part a response to the range of economic problems the country faced in the first few years of independence (Ibhawoh and Dibua, 2003). The central objective was to achieve self-reliance, combining a modernisation paradigm with a strong emphasis on social equity and distributive justice (ibid.). This led to the nationalisation of key sectors of the economy, including agricultural processing industries,²⁰ and a push towards rural villagisation and collective production.²¹ It is unclear to what extent the latter affected smallholder irrigation during this period. Given that villagisation efforts were largely concentrated in areas with low agricultural production, many irrigators may have been spared (Therkildsen, 2011). For example, farmers in Kilimanjaro and other mountainous areas were already deemed to be in villages, though this was not the case in the Rufiji Valley or Sukumaland (Andrew Coulson, pers. comm.).

²⁰ The government continued to invest in large-scale farming in selected areas (URT, 2013b), for example taking ownership of the Kilombero Sugar Estate (Kamau, 2015).

²¹ The development of Ujamaa villages was advocated, in which people would have their homes around a common service centre instead of living on scattered homestead plots, and land farmed by cooperative groups rather than by individual farmer. The villagisation process was largely unsuccessful and met with resistance in many areas. By 1975 the policy has been informally abandoned (Ibhawoh and Dibua, 2003).

Whereas Ujamaa arguably had some successes in terms of improving social services and maintaining political stability (Ibhawoh and Dibua, 2003), the agriculture sector stagnated, causing a substantial reduction in productivity and incomes (URT, 2013b).²² Over-bureaucratisation and centralisation also created inefficiency and opportunities for corruption (Ibhawoh and Dibua, 2003), and a multitude of new state corporations became mired in debt (Meredith, 2005). Compounded by factors such as drought and sharp increases in global oil prices, Tanzania's economy performed badly throughout the 1970s and collapsed in the early 1980s (Ikeno, 1992). As a result, the government was forced to turn to the International Monetary Fund (IMF) for support and the country became heavily indebted. The IMF began to impose conditions on further loans, which led to structural adjustment and liberalisation (Ibhawoh and Dibua, 2003). Consequently, during the late 1980s and 1990s, the Tanzanian economy underwent a transformation that redefined the roles of public and private sectors in agricultural development (Box 3).

At the end of the 1990s the Tanzanian government set out an ambitious vision to industrialise the national economy and become a middle-income country in 25 years, a key part of this vision being 'a modernized, commercialized, competitive and effective agriculture system' (MAFC, 2016). Global concerns over food security and climate change have meanwhile helped rekindle international interest in developing Tanzania's

²² Agriculture declined by 10% between 1979 and 1982, and the average standard of living between 1975 and 1983 fell by nearly 50% (Meredith, 2005).

Box 3: Economic liberalisation – implications for the agriculture sector

The evolution of Tanzania's agriculture sector towards market orientation and reduced intervention by the state culminated in the Agricultural and Livestock Policy of 1997. Salient features of this policy were:

- The liberalisation of all agricultural markets and removal of state monopolies over exports and imports;
- Withdrawal of the state from agricultural production;
- A focus on food security at national and household levels;
- Emphasis on the private sector as an engine of growth in crop production, processing and marketing;
- Decentralisation of public agricultural extension services and transfer of administrative responsibility to LGAs;
- Improving security of tenure and allocation of land.

The government's role was effectively reduced to the provision of public support services and sector regulation, while tax-based (and other) incentives were introduced to attract private investors in a wide range of agricultural and agribusiness activities.

Source: URT (2013b).

agricultural and irrigation potential, including from the private sector (Booth et al., 2014).²³

Water management also features strongly in CAADP, endorsed by African heads of state in 2003, which seeks to achieve agricultural growth rates of 6% in signatory countries and secure 10% of the national budget for the sector (Cooksey, 2013).

Although Tanzania has not met the CAADP targets (Cooksey, 2013), the launch of the ASDP in 2006 led to substantial increases to the agricultural budget, including basket funding from donors (Therkildsen, 2011). The ASDP effectively operationalised the 1997 Agriculture and Livestock Policy²⁴ and the 2001 sector strategy (both since updated – see Table 2), with

²³ Economists such as Hans Binswanger (World Bank) and experts from the Ministry of Agriculture, Food Security and Cooperatives (MAFC) stress that 'food crops are where Tanzania's comparative advantages lie' (Coulson and Diyamett, 2012). The 2009 National Rice Development Strategy sets a target to double production to 2 million tonnes by 2018. Agreements for a number of large mechanised rice projects have since been signed, or are being considered, several for which would export rice back to their donor countries (ibid.).

²⁴ Updated in 2013.

the aim of boosting smallholder productivity, food security and incomes.²⁵ Interestingly, irrigation did not feature strongly in the first iterations of the ASDP, nor was it a central issue in the CCM election manifesto or campaign. The target of 1 million ha was included later on in the ASDP drafting process, following an announcement by President Kikwete in 2005, which appears to have taken even his own advisors by surprise (Therkildsen, 2011). Although not all donors were happy with the change in emphasis, the World Bank endorsed a focus on smallholder irrigation (Cooksey, 2013), which has remained a political priority since. ASDP funds have supported the upgrading of traditional smallholder schemes and the building of new ones, though 50% of funds have been spent on rehabilitating existing infrastructure (URT, 2011c).

²⁵ The ASDP was slow to take off owing to disagreements with donor agencies (Cooksey, 2013). Many contentious issues emerged during the formulation process, reflecting divergent views regarding the role of the state and the private sector (Therkildsen, 2011).

Irrigation governance in Tanzania

Tanzania has an array of government institutions relevant to irrigation development and sustainability. The most important at national level are the Ministry of Agriculture, Food Security and Cooperatives (MAFC) and the Ministry of Water and Irrigation (MWI) (see Table 2 for a summary of their functions). In recent history, the Irrigation Department has been shuffled multiple times between these two ministries, disrupting planning and implementation activities. At present the department (now a commission) is answerable to the latter but physically located in the former's offices (Interviews A and B).

The 2013 Irrigation Act provided for the establishment of a National Irrigation Commission, which was formed about a year later, promoting the existing department to semi-autonomous status.²⁶

²⁶ In practice it is too early to tell if things have changed significantly. Most of the staff in the Commission were previously working in the Irrigation Department, although a director-general post is currently being recruited (Interview A; the advert is also advertised online).

According to the new law, the Commission is the main government body responsible for investing in, coordinating, monitoring and regulating irrigation activities in Tanzania (URT, 2013c). Meanwhile, the mandate for planning, design, construction and rehabilitation of community-managed schemes has been devolved to the LGAs, resting with the district agricultural offices, while zonal irrigation office engineers play a supporting role (Therkildsen, 2011).

Managing smallholder irrigation schemes is the responsibility for water user groups, which, according to the Act, are supported by the government to register as irrigation organisations (IOs) and establish by-laws.²⁷ Establishment of a formal IO is now a precondition for obtaining a permit to access water and is mandatory for all new and 'improved' schemes (URT, 2013c). However, governance arrangements vary considerably for older schemes, and formal and informal institutional frameworks have evolved in a rather uncoordinated and sometimes contradictory manner (Patel et al., 2014). For example, the modern scheme at Dakawa was initially managed by NAFCO, and later (following collapse) devolved to farmers, who now have a formalised association with a board and salaried chair. Meanwhile, in the Uluguru Mountains, traditional irrigation is still governed by informal arrangements (Mdee, 2014). Water users in many of the older schemes, and particularly in traditional schemes, do not have IO status or formalised rights (Interview A), which can leave them vulnerable when negotiating with more powerful actors over claims to water (ibid.).

A Water Resource Management Act was passed in 2009, setting out the principles and institutional

framework for water resource management and development in Tanzania. The Act provides for a basin water board for each of Tanzania's major river basins, to be responsible for, *inter alia*, basin planning and management and regulating abstractions. In theory, these boards also play a key role in coordinating inter-sectoral communication among water users. These functions are carried out by an appointed officer and his/her staff, and can also be delegated to catchment committees at sub-basin level, although in practice only three committees have so far been established (Interview E). Some basin offices had been set up prior to the new Act with support from donors as part of the reform process (Interview A). For example, the Rufiji Basin Water Office (now the Rufiji Basin Water Board) was established in 1993 (Maganga et al., 2002, cited in Patel et al., 2014).

At local level, the Act stipulates that water users can voluntarily form WUAs for the purpose of managing resources and securing permits for water use (URT, 2009a). There are currently about 100 WUAs, mainly concentrated in the Rufiji and Pangani River Basins (Interview E). The nature of these associations varies, for example including single-purpose entities such as IOs, as well apex bodies that bring together different water users, such as the WUA established by WWF in the upper part of Great Ruaha (Interviews A and I).²⁸ In theory, LGAs, zonal irrigation offices and IOs collaborate with the Basin Water Board and WUAs, where they exist, for the purposes of planning water allocations and abstractions and collecting fees. In practice, capacities to regulate abstractions and enforce permitting rules are lacking on all sides (Interviews H and J).

²⁸ A study by de Bont et al. (2015) similarly highlights the plurality of local institutions, in this instance on the Nduruma River.

There are a number of national institutions for environmental and climate change governance, whose mandates intersect with the agriculture sector (see Table 2). The Division of Environment (DoE) in the Vice President's Office (VPO) is responsible for drafting key policies and laws and overseeing the process of mainstreaming these into key sector strategies and plans, such as the ASDP. The National Environmental Management Council (NEMC) enforces environmental regulations (Interview L). The DoE also houses the national climate change focal point, who represents Tanzania in international climate change negotiations, among other responsibilities. Coordination of climate change actions across sectors is, in theory, provided by a National Climate Change Steering Committee (NCCSC) and National Climate Change Technical Committee (NCCTC). In principle, both committees are functioning but they do not appear to meet regularly (Yanda et al., 2013).

Finally, Tanzania remains heavily reliant on external support from donors, the international financial institutions (IFIs) and INGOs. These actors were highly influential in the development of the ASDP (Therkildsen, 2011). Although there is little evidence that large investments in irrigation were a priority prior to 2005, either for government or for development partners, several donors and IFIs are now providing support to smallholder irrigation development through the ASDP basket fund and/or project-based initiatives (Interview B) (see Table 2). Key actors, such as the World Bank and DFID, have also aligned themselves behind SAGCOT – billed as a public-private initiative to stimulate agricultural growth and attract investment – and are hence supporting commercial agriculture and irrigation development. Meanwhile, basin water boards are receiving some support from

²⁷ IOs are often referred to as WUAs.

donors, including DFID and the German Agency for International Cooperation (GIZ), to support their day-to-day activities and develop

integrated water resources management (IWRM) plans (Interviews A and E). INGOs such as WWF and the International

Union for Conservation of Nature (IUCN) have helped establish catchment management platforms at local level (Interview I).

Table 2: Relevant actors in the irrigation sector in Tanzania

Local level
<ul style="list-style-type: none"> • IOs: Legally registered groups of water users responsible for managing, operating and maintaining irrigation schemes, including the collection of fees, paying for the water permit and enforcing by-laws • WUAs: Voluntary organisations that can be formed by water user groups for the purposes of managing resources and obtaining permits; responsible for enforcing by-laws • Village leaders: Play a vital role in land allocation
Subnational level
<ul style="list-style-type: none"> • Basin water boards: Responsible for (cross-sectoral) basin planning and management, resource monitoring and water allocations; issue and enforce water permits, including for irrigation • Zonal irrigation offices: Provide technical assistance to LGAs for irrigation development • LGAs/district agriculture offices: Responsible for implementing the ASDP at district level, including the planning, design and construction of irrigation schemes
National level
<ul style="list-style-type: none"> • Irrigation Commission: A semi-autonomous (parastatal) organisation responsible for overseeing, monitoring and regulating irrigation activities • MAFC: Responsible for policy formulation, coordination and monitoring for the agriculture sector; supports the provision of technical services to farmers, for example by LGAs; manages food reserves and early warning systems • MWI: Oversees the development, management and use of water resources, and WASH service delivery; responsible for water sector policy formulation and implementation, legislation, regulation and monitoring; provides technical support to LGAs and basin water boards • National Water Board: An advisory board to the minister on matters related to multi-sectoral coordination in integrated water resources planning and management as well as resolution of water conflicts • DoE, VPO: Responsible for developing Tanzania’s environmental and climate change policies, and supporting sector implementation; houses the United Nation Framework Convention on Climate Change focal point • NEMC: Enforces environmental regulations; reviews and monitors environmental impacts assessments, including for irrigation projects • NCCSC and NCCTC: Facilitate the coordination of climate change actions across sectors
International actors
<ul style="list-style-type: none"> • World Bank: Supporting the SAGCOT initiative; contributes to the ASDP basket fund; supporting the expansion of rice production including irrigation and drainage infrastructure development • USAID: Supporting infrastructural improvements on the Dakawa rice irrigation scheme as part of its Feed the Future programme • JICA: Contributes to the ASDP basket fund; capacity-building for Arusha Technical College staff to teach irrigation engineering; supporting rice industry development, including previous funding for Dakawa irrigation scheme • DFID: Supporting the SAGCOT initiative; some funding for capacity-building of the Rufiji Basin Water Board to collect hydro-meteorological data • IFAD: Previously contributed to the basket fund under the ASDP, under which smallholder irrigation development was a key activity; currently supporting a public–private partnership initiative for sugarcane production in Bagamoyo • Others include AfDB, IUCN, WWF, GIZ, Irish Aid

Government policies, strategies and initiatives

Economic and social development

Tanzania's direction and philosophy for long-term economic and social development are laid out in Vision 2025, which articulates an ambition is to become a middle-income country by 2025 based on principles of sustainable development. The framework for putting this vision into practice is provided by the first and second National Strategy for Economic Growth and Reduction of Poverty (NSGRP), also known by the Swahili acronym MKUKUTA. A series of five-year national

development plans (the second of which has been recently released) complement the medium-term strategy, charting out a growth pathway towards meeting the Vision 2025 objectives. These objectives include 100% food self-sufficiency by 2025.

Agriculture

Agricultural policy in Tanzania is a somewhat confusing picture at present, which may be a reason for the delay in finalising ASDP2. In theory, agriculture sector priorities are rooted in Tanzania's Agriculture Sector Development Strategy (ASDS1, 2001; ASDS2, 2013) and the National Agricultural Policy

(2013). The main vehicle through which these are implemented is the ASDP (2006–2016).²⁹ Irrigation is a key component of the ASDP, allocated more than 70% of resources, and will remain prominent in ASDP2 (Interview C). Under ASDP1, a National (NIDF) and District Irrigation Development Fund (DIDF) have been established to allocate funding on a competitive process, the former financing larger schemes (Therkildsen, 2011).

²⁹ About 60 percent of the national agricultural budget was allocated to the ASDP for the period 2006/7 to 2010/11 (URT, 2011c).

Box 4: Tanzania's ambitious targets for agricultural development

- 10% of national budget to be allocated to agriculture (Kilimo Kwanza, 2009);
- Agriculture sector growth rates of 6% per annum (TAFSIP, 2011/1–2020/21);
- 1 million ha of new irrigation to be developed by 2016 (ASDP, 2005/0–2015/16)
- Doubling rice production to 2 million tonnes by 2018 (National Rice Development Strategy, 2009)

Since implementation of the ASDP began in 2006, the government has launched several high-profile initiatives in which irrigation features strongly. *Kilimo Kwanza* ('Agriculture First', 2009) is billed as Tanzania's green revolution initiative. While MAFC 'owns' the ASDP, Kilimo Kwanza sits under the Prime Minister's Office and receives the patronage of the Tanzania National Business Council and the Agricultural Council of Tanzania, effectively excluding MAFC (Ngaiza, 2012, cited in Coulson, 2015). Moreover, the ASDP centres on smallholder agriculture whereas Kilimo Kwanza views the private sector as the engine of growth,

promoting large-scale commercial farming.

The *Southern Agricultural Growth Corridor of Tanzania* (SAGCOT), launched in 2011, has been dubbed 'Kilimo Kwanza in action' (Cooksey, 2013). It is 'a public private partnership aimed at catalysing inclusive and sustainable private sector led agricultural development' (SAGCOT Centre, 2015). The initiative seeks to contribute to food security, reducing poverty and spurring economic growth in Tanzania through the development of a cohesive, modern commercial agricultural area in the 'Southern Corridor'. This is to be achieved

through improving processing, transport and marketing infrastructure; enhancing local businesses to bridge the gap between smallholders and larger markets; and promoting eco-certification and market differentiation to link smallholders to lucrative export markets for key crops (ibid.). The SAGCOT Centre acts as a neutral broker between the government and private companies (Interview N). While SAGCOT is presented as a government initiative, evidence suggests it was in fact conceptualised and driven by

external actors (Coulson, 2015; Cooksey, 2013).³⁰

Inspired by Asian models of development, *Big Results Now* (BRN, 2013) aims to fast-track development and achieve 'quick wins' in six priority sectors, one of which is agriculture. The proposal targets both smallholder and commercial agriculture and includes setting up collective rice irrigation and marketing schemes, as well as targeting maize and sugarcane production (Interview D; Coulson, 2015). It is hoped that most of the funding for infrastructure development will come from donors and private investors (Coulson, 2015). However, as one key informant admitted, 'we have not succeeded much in this endeavour as funding has been a challenge' (Interview D). BRN is implemented through a new Presidential Delivery Bureau located in State House (Cooksey, 2013), but most staff sit in the relevant ministries.

To complete the picture, there have been externally driven efforts to expand the ASDP and align it more closely with CAADP, resulting in the Tanzania Agriculture and Food Security Investment Plan (TAFSIP, 2011/12–2020/21). However, TAFSIP has had little political buy-in and has played a very secondary role to the abovementioned policies and initiatives (Cooksey, 2013). As one key informant succinctly put it, 'TAFSIP is just an instrument for coordinating investment' (Interview A).

³⁰ SAGCOT's origins are difficult to determine and interviewees from the Centre were reluctant to disclose details. Coulson (2015) claims it was developed by a British consultancy firm, AgDevCo, with the support of the fertiliser producer Yara International and a range of powerful international organisations and donors. Meanwhile, Cooksey (2013) states that the investment blueprint for SAGCOT was developed by the Tanzanian Agricultural Partnership and funded by the Norwegian Embassy in Tanzania, with Yara (a Norwegian company) a SAGCOT partner, early investor and aid beneficiary.

Irrigation

Government priorities for irrigation have mostly been captured above with respect to the agriculture sector. Nevertheless, Tanzania has a number of dedicated policies for irrigation that also deserve a mention. The 1 million ha target set in the ASDP (which has not been met) is far higher than that proposed in the *National Irrigation Master Plan* (NIMP), which considers 405,000 ha of (additional) irrigated land within 15 years to be feasible (JICA, 2002). The plan prioritises smallholder irrigation development, and observes that, whereas Tanzania has significant irrigation potential, there is little capacity to exploit this at present. The need for a dedicated policy, legal and regulatory framework is strongly emphasised (*ibid.*). To a large extent, this has been provided by the National Irrigation Policy (2010) and *National Irrigation Act* (2013), although it will take time to embed the new governance structures (described above in Section 3.2.2) and hence improve irrigation performance over the long term.

Water resource management

In 2002 the Tanzanian government issued the *National Water Policy*, which sets out key principles for the sustainable management and development of water resources, with river basins or sub-catchments as the principle management unit. The policy recognises the complex linkages between water and sectoral development and that water has both a social and economic value. It calls for the adoption of IWRM in Tanzania, promoting participatory decision-making and devolving responsibility for service delivery to the lowest levels of government (ICID, 2012; Interview E). To implement the policy, MAFC has developed a *National Water Sector Development Strategy* (2006–2015) and a *Water Sector Development Programme* (2006–2025). Most recent is the *Water Resource Management Act*

(2009), which clarifies the institutional framework for IWRM and institutional mandates (described in Section 3.2.2), giving the basin water boards legal recognition.

Environment and climate change

There are a number of national policies and strategies that seek to mainstream climate and environment issues into key sectors of the Tanzanian economy (see Box 5 and Table 3). Although climate change is relatively new on the agenda (Yanda et al., 2013) the second national development plan (NSGRP2) does make explicit reference to the risks climate change poses to poverty and reduction and inclusive economic growth. Agriculture is identified as one of the most vulnerable sectors to climate variability and change and therefore a priority for adaptation efforts. It is also the first sector to develop its own plan for mitigating these risks – namely, the *Agriculture Climate Resilience Plan* (ACRP, 2014–2019). ACRP recognises that irrigation is important, but 'irrigation alone will not be sufficient to adapt to climate change' and can in fact 'indirectly drive vulnerability if water resources are not well managed' (URT, 2014: p.v). The ACRP calls for measures to improve water, soil and land management to build the resilience of both smallholders and commercial farms.

Box 5: National Climate Change Strategy – strategic interventions relevant to agriculture

Crop choice

- Assessing crop vulnerability and suitability (including cropping pattern) for different agro-ecological zones;
- Promoting early-maturing and drought-tolerant crops, use of pest/disease tolerant varieties and adoption of higher-yielding technologies.

Farm management

- Addressing soil and land degradation by promoting improved soil and land management practices/techniques;
- Strengthening integrated pest management techniques;
- Promoting appropriate indigenous knowledge practices, agro-forestry systems, minimum tillage and efficient fertiliser utilisation and best agronomic practices such as conservation agriculture technologies;
- Enhancing management of agricultural wastes.

Markets

- Assessing trade comparative advantage on traditional export crops with a changing climate;
- Enhancing agro-infrastructural (input, output, marketing, storage) systems;
- Strengthening post-harvest processes and promoting value addition;
- Development of crop insurance strategy.

Water

- Promoting appropriate irrigation systems;
- Protecting and conserving water catchments;
- Enhancing exploration and extraction of underground and other supplemental water sources;
- Facilitating and promoting water recycling and reuse and rainwater harvesting.

Information

- Strengthening early warning systems for pest surveillance;
- Strengthening weather forecast information sharing for farmers.

Source: Adapted from URT (2014).

Table 3: Summary of key national policies relevant to irrigation

Policy	Summary
Economic and social development	
Vision 2025	Sets out Tanzania's long-term development vision to move from a least developed to a middle-income country by 2025. Food security and self-sufficiency are listed among the key targets.
National Strategy for Economic Growth and Reduction of Poverty 1&2/MKUKUTA (2005–2010 and 2010–2015)	National framework for poverty reduction. It aims to reduce poverty through growth and reduction of income poverty, improved quality of life and social well-being and good governance and accountability. (The strategy for 2016 onwards is currently being developed and has not yet been made public.)
Big Results Now (2013)	An initiative largely designed to speed up policy implementation in six priority sectors: education, health care, water supply, power, roads and agriculture; includes smallholder and commercial irrigation investment.
Agriculture	
National Agriculture Policy (2013)	Aims to develop a competitive and profitable agricultural industry and improve rural livelihoods while attaining broader-based economic growth; advocates the use of irrigation to improve food security, raise agricultural productivity and increase incomes.
Kilimo Kwanza/'Agriculture First' (2009)	A national resolve to accelerate agricultural transformation; there are 10 pillars, one of which is infrastructure development, including irrigation infrastructure.
Agricultural Sector Development Strategy (2001)	Provides a basis for action by both public and private sector stakeholders to support Tanzania's efforts to stimulate agricultural growth and tackle food insecurity and rural poverty.
National Rice Development Strategy (2009)	Aims to progressively transform the existing subsistence-dominated rice subsector into commercially and viable production systems; strategic areas include the rehabilitation and development of new irrigation schemes and improving irrigation and water harvesting technology.
Agricultural Sector Development Programme (2006–2016)	The core agriculture programme developed and implemented by MAFC, a large part of which is focused on irrigation expansion. (ASDP 2 is currently being finalised.)
Tanzania Agriculture and Food Security Investment Plan (2011/12–2020/21)	Described as an expanded version of the ASDP and 10-year roadmap for the sector. TAFSIP is designed to operationalise the objectives of CAADP. The main thematic areas include irrigation development.
Southern Agricultural Growth Corridor of Tanzania (2011)	A public–private partnership dedicated to ensuring food security, reducing poverty and spurring economic development in Tanzania's 'Southern Corridor', through the development of inclusive agricultural value chains.
Irrigation	
National Irrigation Master Plan (2002)	Proposes an irrigation development programme for

Policy	Summary
National Irrigation Policy (2010)	<p>smallholder schemes to be implemented by 2017; emphasises the need for a dedicated policy, legal and regulatory framework for the irrigation sector.</p> <p>Provides direction for the implementation of irrigation interventions; aims to ensure optimal availability of land and water resources for agricultural production and productivity.</p>
National Irrigation Act (2013)	<p>Includes legal provisions for the development, operation and maintenance of irrigation schemes; construction of irrigation works; sector governance and institutions, including the National Irrigation Commission, district-level departments and IOs.</p>

Water resource management

Water Policy (2002)	<p>Calls for the adoption of IWRM; seeks to address cross-sectoral interests in water and watershed management; promotes participatory water resources planning.</p>
Water Sector Development Strategy (2006–2015)	<p>Guides the formulation of the Water Sector Development Programme, prioritising interventions to address water sector challenges; supports alignment among sector policies related to water – namely energy, irrigation, industry, mining and environment.</p>
Water Sector Development Programme (2005–2025)	<p>Comprehensive programme that covers rural and urban water supply and sanitation, water resource management and institutional capacity-building; irrigation systems are among the priorities identified for water infrastructure investment (to be addressed by the ASDP).</p>
Water Resource Management Act (2009)	<p>Provides the legal and institutional framework for water resources development and management and establishes key principles for IWRM.</p>

Environment and climate change

National Environmental Policy (1997)	<p>Emphasises environmental protection and sustainable natural resource management; calls for cross-sector planning and coordination and mainstreaming of environmental considerations into sector policies and plans (the policy is currently under review).</p>
Environmental Management Act (2004)	<p>Provides the legal framework and enabling instruments to implement the National Environmental Policy; among other things, it prescribes that the minister responsible for the environment would assume the national leadership role on climate change.</p>
National Adaptation Programme of Action (2007)	<p>Identifies immediate and urgent climate change adaptation actions that were also considered robust enough to lead to adaptation in the long term; agriculture and freshwater resources were the top ranked priority areas; proposed projects included irrigation and water harvesting.</p>
National Climate Change Strategy (2012)	<p>Identifies measures to address climate change and provides a platform for sector integration on climate change in policy and sector strategy formulation; elaborates roles and responsibilities of key sectors; identifies strategic</p>

Policy	Summary
Agriculture Climate Resilience Plan (2014–2019)	<p>interventions, which include the promotion of ‘appropriate’ irrigation.</p> <p>Responds to most urgent impact posed by climate variability and change to the crop productivity, with a view to building resilience of current and future investment. The plan seeks to mainstream climate change within agriculture policies, strategies, initiatives and plans. Irrigation is recognised as necessary but not sufficient to build resilience.</p>

4. From policy to practice: Drivers of change and performance bottlenecks

4.1 Drivers of policy change

Political and ideological change

Since independence, agriculture has remained central to Tanzania's economic and social development policies. Yet, as we have described, the sector has undergone two significant transformations as a result of political and ideological change – the first associated with Tanzania's socialist period, the second because of structural adjustment and an externally driven neoliberal agenda. These competing ideologies (simply put, government- versus market-led development) continue to shape policy discourse today. For example, many of the contentious issues emerging during the ASDP formulation process reflect divergent views regarding the role of the state and the private sector (Therkildsen, 2011). As Coulson and Diyamett (2012) observe, those who have grown up with a model in which the government is responsible for delivering development find it difficult to accept a backseat role for the state as 'facilitator' or 'enabler'. Interestingly, while ASDP is largely based on a state-centred rationale, Kilimo Kwanza represents a departure from this ideology, advocating public-private partnerships and joint ventures (Booth et al., 2014). This may in part be a pragmatic move, recognising that 'participation of private capital is key to resolving the prevailing budgetary resource constraints' (URT, 2009d: 3).

Interest in irrigation development over the same time period has waxed and waned, recently becoming a political priority following President Kikwete's 1

million ha pledge in 2005. In fact, the level of investment being channelled into the sector today has not been seen since the 1960–70s (Andrew Coulson, pers. comm.). The motivations behind Kikwete's statement remain unclear. However, Therkildsen (2011) suggests that, among other factors, ideological notions about modernisation motivate the ruling elite to push for irrigation development. Certainly, modernisation lies at the heart of Tanzania's agricultural policies (e.g. URT, 2013b) and CCM views irrigation an essential component in bringing about an agricultural revolution (Therkildsen, 2011).

Macroeconomic crisis: Causes and effects

Tanzania's economic collapse in the early 1980s was a significant turning point in the country's political and economic history. The collapse was caused by a number of disasters, which compounded existing problems associated with state inefficiency and the underperformance of key sectors such as agriculture. The country was hit by a severe drought and the first global oil crisis in the early 1970s, both of which struck again in the early 1980s, followed by a third (continental) drought in 1983/84 (Ikeno, 1992; Meredith, 2005). These shocks had serious repercussions for agricultural productivity (and hence food security) and exports. Meanwhile, the collapse of the East Africa Community and the war with Uganda in the late 1970s further reduced economic and political stability (Ikeno, 1992). In an attempt to rescue the economy, and under significant pressure from the IMF, the Tanzanian government introduced the National Economic

Survival Programme in 1981 and the Structural Adjustment Programme in 1982, the first of several recovery programmes.

As noted previously, state investments in agriculture, and hence irrigation, were very low in the late 1980s and 1990s. This was, in large part, a direct result of structural adjustment that led to significant cuts in public expenditure. Although much of the responsibility for infrastructure management and maintenance was passed on to farmers as a result, they nonetheless remained heavily dependent on the state (Patel et al., 2014). The introduction of neoliberal policies also meant markets for agricultural products were disrupted at a time when prices for export crops were falling (because of the global financial crisis). As a consequence, production decreased (Coulson, 2010). This contributed to a general feeling of despair regarding the potential of smallholder farming and reinforced the view that agricultural modernisation and state intervention were needed (Andrew Coulson, pers. comm.).³¹

Foreign aid and investment

Despite the continued emphasis on self-reliance in Tanzanian policies, the country remains heavily dependent on external actors for financial and technical support. This gives donors and IFIs, in particular, a significant degree of leverage in policy-making and planning processes. For example, the ASDP was slow to take off because of

³¹ Coulson and Diyamett (2012) argue that this despair was not wholly founded, as smallholder agriculture had performed well in the years before and after independence. However, those who continue to hark after mechanised agriculture find it hard to accept that such farming systems can generate surpluses.

disagreements with donor agencies (Cooksey, 2013) and actors such as the World Bank have been particularly influential in shaping the programme (Therkildsen, 2011). Nonetheless, the recent push for irrigation expansion appears to come from government: initiatives such as Kilimo Kwanza and BRN are fundamentally state-controlled projects (the exception is perhaps SAGCOT). While the strong emphasis on irrigation initially met with resistance from some quarters, the World Bank, the African Development Bank (AfDB), the Japan International Cooperation Agency (JICA), the United States Agency for International Development (USAID) and others have subsequently provided substantial funds in support of small-scale irrigation. Interestingly, the preparation of the Irrigation Policy was part of budget negotiations in 2008 (Therkildsen, 2011).

Since 2007/08, rises in food prices have led industrialised countries and multinationals also to show great interest in African agriculture. Given that Tanzania claims to have huge tracts of underutilised agricultural land, actively promotes itself as a safe country for investment and has enacted a number of tax-based incentives to attract companies, it has become a prime target for foreign direct investment in agriculture (Booth et al., 2014; de Bont et al., 2015). For example, agreements for a number of large mechanised rice projects have since been signed, or are being considered, several of which would export rice back to their donor countries (Friis and Reenberg, 2010). Moreover, private investors and their representative bodies have played an important role in conceptualising and promoting Kilimo Kwanza (e.g. Tanzania National Business Council) and SAGCOT (e.g. Yara International), which is an indication of their influence over high-level decision-making. On the other hand,

contestations over land, lack of government support and excessive bureaucracy serve to discourage investors. 'There is a strong sentiment among Tanzanians that the land and its resources should benefit Tanzanians, and should not be in foreign hands' (de Bont et al., 2015). Hence the policy narratives around foreign direct investment are conflicting.

Climate risks

Tanzania's national policies recognise that climate variability and extremes, such as drought, pose a considerable risk to agricultural production, and hence poverty reduction and economic growth (URT, 2014). In the past, droughts have contributed not only to food insecurity but also to macroeconomic instability (discussed above). The country's dependency on rain-fed agriculture makes it particularly vulnerable, and irrigation is considered a vital component of plans to achieve food self-sufficiency and build resilience (URT, 2014; Interview B). However, unlike in Ethiopia, Morocco and Zimbabwe (Oates et al., 2015; Mosello et al., 2016), we found little evidence that the recent political interest in irrigation expansion has been driven by concerns over climate risks *per se*. 'Climate change is an issue that is discussed a lot but it is seen as something that will manifest in the future' (Interview E). Certainly, climate change is relatively new on Tanzania's policy agenda – it is notable that Vision 2025 does not highlight it as an issue, for example (Yanda et al., 2013). Moreover, although water scarcity is a problem in certain river basins, the country is generally considered water-rich, and investing in water resource management (WRM) is not currently a top priority for politicians, given more immediate concerns. 'Water service provision is prioritised more politically, as it touches on the lives of the people, whereas WRM is less visible in terms of benefits' (Interview E).

4.2 Bottlenecks to increasing irrigated agricultural productivity

National level: Developing the irrigation sector

We noted above that some progress has been made towards the ambitious targets for irrigation development outlined in the ASDP.³² There have also been further high-profile initiatives to boost investment in sector expansion, such as SAGCOT, where significant areas are earmarked for irrigation development. Nonetheless, a number of bottlenecks hinder the execution of government policies and contribute to poor performance in the irrigation sector. Here, our focus is on government-supported small-scale irrigation.

A first, critical, factor is *political motivation*. Party politics and the desire to remain in power not only shape policy goals but also can serve to undermine their achievement (Booth et al., 2014). Although irrigation is relatively new on the agenda, the agriculture sector in general has long been an important policy area for vote winning. Policy implementation problems arise, however, because winning elections and maintaining coalitions are more important goals for politicians than delivering on sector targets and objectives (e.g. see Therkildsen, 2011 on rice). Meanwhile, the prevailing political economy makes it difficult for citizens to hold the government to its promises (Booth et al., 2014). This has meant that, although the president has made bold pledges regarding irrigation expansion, there has been less incentive to ensure investments are adequate, effective or equitable.

³² According to one key informant, around 300 schemes have been improved or rehabilitated under the programme (Interview A).

To give an example, evidence from one district indicates that ASDP investments are generally designed to benefit as many constituents as possible in order to secure votes, with little attention to economic viability or local needs (Therkildsen, 2011). Because public funds have been overstretched, projects are delayed and many schemes are half built (this problem is widespread – reported in Interviews C, D and F). On a related note, a large proportion of ASDP funds are channelled into infrastructural development whereas few resources have been deployed in support of scheme management (Interviews B and F). This suggests a preference for quick and tangible results – infrastructure provides a very visible symbol of political patronage – at the expense of long-term sustainability. Donors are as much to blame here as government in this regard (Interview F).

Corruption is also endemic in Tanzania at all levels of government, diverting resources from the production of crucial public goods and services and, for private investors, increasing the costs and unpredictability of doing business (Kelsall, 2013). Donor assistance to agriculture has similarly been undermined by local patronage networks (Booth et al., 2014). Although the new prime minister appears to be clamping down on corruption – several high-ranking officials are being tried in court for the mismanagement of large contracts – it remains to be seen whether this will result in any deep-seated changes (Interviews A and J). Corruption is a difficult subject to broach, particularly with government officials. However, one key informant claimed that, in the irrigation sector, there were numerous instances in the procurement process of money going missing or payment for incomplete works (Interview F).

Second, new policy initiatives have led to a *proliferation of institutions*

for irrigation development, and yet have noticeably failed to tackle existing administrative and capacity issues. The mandate of the Irrigation Commission has been encroached on by new initiatives, which, being flagship political projects, are largely outside its control (e.g. Kilimo Kwanza and SAGCOT), exacerbating problems such as poor coordination, inefficiency and weak accountability. Irrigation is also cross-sectoral in nature, yet collaboration between the two key ministries – MAFC and MWI – is very limited (Interview A). This apparent gap in strategic planning, both within and between sectors, means *investments are not well coordinated*.³³ Hence there is a danger that key enabling factors or constraints, such as those related to availability of water resources in the dry season or access to markets, are not adequately accounted for by irrigation projects (see Nkonya, 2013).

Meanwhile, despite the large proportion of agricultural spending devoted to irrigation, little has been done to alleviate the *severe shortage of human capacity* in the sector. Several donors have withdrawn from the ASDP basket fund owing to the lack of coordination and capacity to implement the programme, especially in the DIDF (Interview A). For example, zonal irrigation offices are thinly staffed and, despite the growing influence of LGAs, there is a significant gap in technical expertise at this level (Therkildsen, 2011). One key informant explained how the shift in policy emphasis towards market liberalisation had left engineers to manage procurement processes, while the construction of schemes was contracted out to private suppliers – neither party having the relevant skills. ‘You have companies from the housing sector building

³³ Lack of coordination was a major criticism of ASDP1 and several donors pulled out as a result (Interview A).

irrigation schemes, while irrigation officers are producing the designs on their behalf’ (Interview F).³⁴ *Financial capacity also remains a significant constraint* – for example, cited as a key reason for lack of progress in the irrigation component of BRN (Interview D). Irrigation investments are expensive and public finance limited. Thus, for pragmatic reasons, there is great interest in ‘getting the private sector involved’ (Interviews B and C). Untimely disbursement of funds also hinders implementation at local level (informal conversation with a zonal irrigation engineer).

Third, although provided for in the new Irrigation Act, there has been little consideration of, or funding for, *scheme operation and maintenance*. Therkildsen writes,

‘The main unsolved problem is that the ASDP pushes for the rehabilitation or construction of new schemes without much attention to their operation and maintenance. Many schemes will therefore eventually stop functioning, as past experiences with irrigation infrastructure have clearly shown. Consequently, the impacts on productivity, production and incomes are likely to be short-lived’ (Therkildsen, 2011: 8; see also Nkonya, 2013).

Although the Irrigation Commission identified improving the management of schemes and capacity-building for farmers as a priority, key informants confirmed that inattention to ‘software’ was a major gap in practice. ‘The irrigation people in the ministry don’t have much interest in software. They are discussing physical results – the area covered, headworks built, kilometres cemented, etc.’ (Interview F). In their defence, government experts explained, irrigation was capital-intensive and required large upfront investments

³⁴ Private consultancy firms may also be contracted to design irrigation schemes (Interview J), although perhaps this is more common for larger projects.

in infrastructure; ‘without this we cannot continue with the rest’ (Interview B). Nonetheless, there is a strong engineering bias among sector professionals and limited attention to important institutional or socioeconomic factors. For example, a critical assumption is that farmers will pay for scheme maintenance and undertake minor repairs, but many are new to irrigation, have no idea what things cost and lack even basic skills (Interviews A, F and J). Consequently, IOs underperform and remain dependent on government for financial and technical assistance. Meanwhile, there is little acknowledgement of, or learning from, successes in the informal irrigation sector (see also Mdee, 2014).

Basin level: Managing water resources

Water availability poses a major challenge for expanding irrigation in areas where demand is already high (Nkonya, 2013). In the Great Ruaha catchment of the Rufiji River Basin, competition between water users is intensifying and conflicts are common (Patel et al., 2014). Since the early 1990s, there have been a number of years in which the river has dried up completely during the dry season, and there are concerns regarding the impact reduced flows are having on the Ruaha National Park (and hence tourism) and hydropower generation downstream (Franks et al., 2004). Over-abstraction and inefficiency in the irrigation sector is often blamed, although evidence shows these are not the only contributing factors (Lankford and Franks, 2000; Lankford and Beale, 2007; see Box 6). On the one hand, smallholder farmers have a relative weak voice in decision-making. ‘Demand for hydropower takes priority so even in normal years irrigation upstream may be restricted; the hydropower sector is more influential’ (Interview E). On the other hand, irrigators in the

Great Ruaha have the advantage of being upstream of other big water users and the proliferation of informal irrigation is particularly difficult to regulate.

A key challenge in managing Tanzania’s river basins strategically is the *lack of capacity to monitor water resources and their use*. Shortage of staff and transport hinders regular data collection and only major rivers are gauged. ‘The Rufiji Basin office has around 20 staff and 25 gauging stations, while the basin is the size of the UK’ (Interview K). In most instances the data collected provide only snapshots and are little used in determining abstractions or seasonality (Interview A). This means permitting is based on insufficient data, and adherence to abstraction limits is difficult to regulate and enforce. Moreover, permits often allocate fixed volumes to users, which may not be appropriate given the natural variability in resources (Lankford and Beale, 2007). Hence, even if water users adhere to their permits, irrigation schemes (and other water users) may be susceptible to periodic water scarcity, particularly in the dry season or in dry years. Downstream irrigators are most at risk in this regard.

Another problem is that the basin water boards, meant to coordinate and approve water-related interventions, are often kept in the dark regarding sectoral, regional or district plans. ‘The mandate of these institutions is very high and they don’t think it is important for basin offices to know’ (Interview H). Thus the boards have relatively little influence over these actors. Moreover, *lack of resources to establish lower-level WRM structures*, which can be an expensive and time-consuming process, makes it difficult for water boards to keep abreast of activities on the ground, and hence regulate water use. ‘River basin offices have

an impossible task to do. The government could at least cover the costs of human resources rather than assuming these offices can be self-sufficient’ (Interview J). In short, IWRM is given lip service but is not a key concern for politicians or donors and hence receives little support. ‘It makes economic sense for Tanzania to invest but WRM is not so visible and is given lower priority’ (Interview K).

Scheme level: Productivity and sustainability

Irrigation clearly has the potential to benefit smallholder farmers in a number of ways, particularly by *increasing yields and incomes*. In the Magozi case study site, both farmers and local experts report a significant change in terms of production and livelihoods. ‘We are seeing improvements in yields. Farmers here used to depend on the government for handouts, now they are free from hunger and have better houses’ (Interview G; confirmed in FGD2). Nonetheless, although irrigation has increased yields significantly, *many smallholder schemes are performing below potential* (Nkonya, 2013). Here, we focus on problems encountered in our three sites in Iringa district – Kiwera (FGD1), Magozi (FGD2) and Igingilanyi (FGD3) – many of which are common to the sector.

In settings where water is a scarce resource and subject to competition between users, there is a particular need to ensure water allocated to agriculture (the biggest user) is used productively – in other words to maximise ‘crop per drop’ (Mdemu et al., 2004). In collective schemes there is also a need to ensure that the allocation of resources among farmers is both equitable and timely. Effective irrigation management is a product of both physical infrastructure and institutions.

Box 6: Water scarcity and inefficient irrigation systems

Making irrigation more efficient is often touted as a solution to increasing water scarcity in the Rufiji Basin. While evidence suggests irrigation expansion is one cause of declining river flows, the relationship between scheme-level efficiencies and water scarcity in the wider basin requires further scrutiny (Baur et al., 2000; Lankford and Franks, 2000; Lankford and Beale, 2007).

- How is efficiency understood? In Tanzania, irrigation efficiency is usually framed in terms of conveyance, particularly the lining of canal systems (Interview J; Lankford et al., 2004). Infrastructure is not the only factor, however. The use of water by farmers at field level and reuse within the scheme is also important. This is rarely considered in the design or management of irrigation systems (Interview J).
- Options for water management at scheme level may not be suitable for the achievement of basin-level objectives (Mdemu et al., 2004). Increasing efficiency in the irrigation system could mean farmers consume more water, and less returns to the river for use downstream (Lankford et al., 2004). Perhaps a more effective way to limit agricultural water use is at the point of abstraction, by redesigning intakes (Bruce Lankford, pers. comm.); however, this would be a very difficult decision to enforce, politically.
- Irrigation expansion is not the only cause of water scarcity in the Rufiji. For example, in the past power cuts at the Mtera and Kidatu hydropower plants have been attributed to low river flows and blamed on poor farmers upstream. This narrative has endured, despite evidence that depletion of the storage reservoir was also caused by mismanagement and excessive releases to maximise power generation, exacerbated by a series of dry years (Lankford et al., 2004).

In sum, while solutions to water scarcity may appear to be technical and managerial in nature, they are often shaped by entrenched practices and powerful economic or political interests. A move away from simplistic assumptions about irrigation efficiency and towards basin-level equity will require deep-seated changes in mind-sets and behaviours.

Source: Adapted from URT (2014).

Although farmers at Kiwera did not report any problems with water access ('there is always water in the canals', FGD1), around 48% of the scheme does not receive irrigation water (Mdemu and Mziray, 2014). The same is true in Magozi, where 50% of the area is not irrigated. *Farmers' ability to manage and allocate water at scheme level is partly determined by infrastructure.* Unlined canals were cited as a problem in the gravity systems of Kiwera and Magozi, and blamed for lack of water in the lower command area (FGD2; also Interview H). Technologies such as sprinkler or drip irrigation, the latter used in Igingilanyi, are generally perceived to be more efficient but are relatively expensive and difficult for smallholders to access and maintain (Interviews B, E and H).³⁵

Magozi suffers from a number of more serious technical problems originating in scheme design. Large areas of the scheme are prone to flooding during the rainy season, and some farmers cannot access water from the canals because of differences in land elevation. Meanwhile, the primary and secondary canals have silted up rapidly because of the design of the intake, reducing water flows to plots (FGD2). Thus deficient engineering serves to undermine agricultural production.

As one key informant noted, however, 'It is not just about infrastructure' (Interview B). A number of experts pointed to common capacity problems that undermine farmers' ability to

manage their scheme effectively, such as *low education levels, lack of skills and experience and weak leadership*, highlighting the need for training and support (Interviews A, B, G and F). Governance challenges also relate to the *capacity to enforce and adapt by-laws* (Mdemu and Mziray, 2014; see also Patel et al., 2014). For example, in Magozi, the association has tried to rectify inequalities in access by rotating water allocations between upstream and downstream areas but found this was difficult to enforce (FGD2). Downstream–upstream conflicts remain a problem. At an individual level, farmers have little incentive to improve water use efficiency unless there are tangible (proven) benefits such as labour saving or increased yields. Even where these incentives exist, many *farmers lack the means to monitor or measure water flows, and do not know how much water to use* (Interview H). To improve

as Lankford (2012) argue many other factors determine efficiency. Interestingly, drip has been adopted successfully by informal irrigators in the Uluguru Mountains of Tanzania, who have access to lucrative urban markets and can afford to invest in new technologies (Mdee, 2014).

³⁵ The relationship between technology type and irrigation efficiency is a contentious one and subject to debate in the literature. Authors such

plot-level water management in Magozi and Kiwera, researchers are trialling new approaches and technologies, such as Sustainable Rice Intensification (Mdemu and Mziray, 2014). Nonetheless, uptake is slow and requires sustained engagement with farmers over long timeframes.

Agricultural productivity is not dependent on water alone; other important factors need to be considered when planning irrigation interventions. Investments in marketing and support services have been limited under the ASDP (Nkonya, 2013). Yet many farmers in our three sites cited problems of *access to inputs, extension services and market reliability*.

'Inputs are very expensive and this affects profits; the market for inputs is not regulated' said Kiwera farmers (FGD1; also Interview A). Farmers in Magozi reported difficulties obtaining fertiliser and lack of knowledge on how to use it (FGD2). Kiwera is closer to Iringa towns and hence the shops, but even here it has been reported that farmers may buy products not suited to their land (Rhodes et al., 2014). Although the District Office is doing its best, it has limited capacity to provide the necessary extension support (Interview G; Mdemu and Mziray, 2014). A panel survey conducted in 2008/09 showed that, nationally, 88% of households have never spoken to an extension agent (Nkonya, 2013).

The main challenges smallholders face regarding markets are unreliability and low prices, exacerbated by lack of access to market information or facilities to store produce. For example, farmers in both Kiwera and Igingilanyi suffered when a glut in tomato production in the district saturated the market and they could not sell their crops (FGDs 1 and 3). Although rice is also considered one of the more profitable crops for local producers and demand is growing (Nkonya,

2013), rice markets are similarly unreliable, in part because of the political economy surrounding import policies, which has served to depress prices (Therkildsen, 2011; Mdemu and Mziray, 2014).³⁶ The combination of high input prices and low market prices makes it *difficult for farmers to make a profit*. 'Our profits are very small. Because of the low prices we get for our crops sometimes there is no profit at all.' (FGD1; also Interview E).³⁷

All three irrigator groups admitted to *challenges in raising funds for maintenance and payment of water fees*, attributing this to low profits. They claimed to have sufficient funds to cover minor repairs but considered major works too expensive, and there was an explicit expectation of ongoing government support. This is in stark contrast with statements by government representatives, and indeed in national policies.

'Reliance on district offices will end; the government and donors won't pay for repairs and maintenance' (Interview J). Several studies show that annual membership fees in smallholder schemes are not enough to maintain and repair irrigation infrastructure (e.g. Nkonya, 2013; Lankford, 2004). Unless this financing gap is addressed, the cycle of build-deferred maintenance-rehabilitation will continue. The National Irrigation Act stipulates that farmers should contribute 5% of their yields but in

³⁶ Around the time that Tanzania began to push for irrigation expansion (important to increase paddy rice production), the East Africa Community agreed to introduce a new tariff on imported rice to boost the domestic industry. However, compliance with the tariff and import restrictions was enforced only partially in Tanzania, and large amounts of illegal imports were allowed into Zanzibar. This exposed local producers on the mainland to unregulated competition and hence served to undermine policy objectives. Why was the tariff not enforced? Because of 1) the need to maintain the fragile union with Zanzibar, where the supply of cheap rice is crucial to winning elections; and 2) the political influence of powerful rice importing companies (Therkildsen, 2011).

³⁷ Reference was also made to the lack of 'a business mind-set' among subsistence farmers (e.g. Interview A).

Magozi, for example, the IO has been reluctant to apply this rule without having a copy of the Act to legitimise enforcement (Makarius Mdemu, pers. comm.).³⁸

There may be a number of reasons why farmers struggle to maintain their schemes, beyond ability to pay. Nkonya (2013) finds little correlation between severity of poverty and payment of membership fees, concluding that community capacity to organise plays a pivotal role.³⁹ Patel et al. (2014) also observe that the prevailing perception of irrigation as a free public service can act as a disincentive to farmer investment. In short, there is a need to better understand the role local capacities, institutions, attitudes and behaviours play in supporting or hindering irrigation management.

4.3 Trade-offs: Winners and losers

In Tanzania, irrigation is often portrayed as an inevitable 'solution' to achieve food security, increase agricultural exports and alleviate rural poverty. We have discussed above how underperformance in the sector hampers the achievement of these objectives. Here, we consider the implications of irrigation policies and investments for equity and inclusion. Irrigation development is heavily dependent on the availability of land, water and financial resources. These resources are in short supply relative to demand, hence there will inevitably be opportunity costs, winners and losers.

There is *little evidence that equity considerations have informed policy decisions or the targeting of agricultural and irrigation investments in Tanzania*. The

³⁸ The Act is not yet available in Swahili, only in English.

³⁹ Although it was not possible to assess local governance arrangements in the time available, the low level of group membership in Magozi and Kiwera case study sites is certainly concerning (Mdemu and Mziray, 2014).

emphasis of key initiatives such as the ASDP, BRN and SAGCOT on high-potential areas, and their apparent neglect of marginal localities, has 'caused an outcry' in some quarters (Interview F). It is significant that the largest share of ASDP investment has gone to Mbeya, Kilimanjaro and Mwanza irrigation zones, for example (Nkonya, 2013). Food-insecure districts in arid and semi-arid areas may suit irrigation development less, yet their livelihoods are still largely agriculture-based and there is a need for public investment (URT, 2014). Devolving planning responsibilities and funds to LGAs should in theory increase responsiveness to local needs. A guiding principle of the ASDP is to empower farmers to control and influence public investments (Nkonya, 2013). In practice, decision-making remains strongly top-down and is often compromised by patronage networks (see Therkildsen, 2011 on the ASDP).

At local level, key informants raised *conflict between pastoralists and irrigators over access to land and water* as an important issue (Interviews B and F; FGD2; various informal conversations); this is also discussed in the literature, for example in relation to the history of the Usangu wetlands, where pastoralists have lost land to expanding irrigation (Patel et al., 2014) and have been forcibly evicted from conservation areas. For example, the current farmer–pastoralist conflicts in Magozi have roots in the displacement of people from the Ilolo area, now part of the Ruaha National Park (FGD2). One ongoing source of tension is the encroachment of cattle onto the irrigation scheme to graze, for example towards the end of the irrigation season, leading to damage to crops. 'There is a lack of control on the movements of pastoralists. We are trying to enforce by-laws and regulations and ensure that land use plans are

there' (Interview B). However, insights from Magozi suggest this is not necessarily a case of 'irrigators' versus 'pastoralists'. The former may tacitly accept the intrusion when their own cattle are included among the pastoralists' herds (Interview A). Rather than enforcing strict rules, enshrined in law, it may be better to negotiate locally appropriate solutions.

There is a danger that insensitive approaches to irrigation development will exacerbate existing patterns of inequality, for example with regard to access to land and water. 'Land ownership is important. Irrigation raises the value of the land. Who has the rights to this land? Who are the original owners? This is not discussed' (Interview F). In Kiwere and Magozi, land tenure is determined by a mixture of customary arrangements, largely based on inheritance, and in the case of Magozi historic government allocations (Pittock et al., 2014). There have been no attempts to redistribute land following scheme construction (unlike in Igingilanyi), although in Kiwere it has been reported that some farmers have allowed their relatives to establish plots (ibid.). Plots therefore vary significantly in size – poorer households having smaller plots on average compared with relatively wealthy household – and *not every household has access to irrigation*. In Kiwere, rental arrangements are also becoming more common. Farmers reported an increasing number of people moving to the area to rent or buy land. Consequently, 'the cost of renting is rising, it has increased from TZS 50,000 per acre in 2006 to TZS 150,000 in 2016' (FGD1), which could mean poorer households are squeezed out. A similar trend has been observed in other locations, where commercial irrigated production is lucrative for smallholders and land rental is on the increase (e.g. Mutabazi et al., 2013).

A household's ability to participate in irrigation, and indeed agriculture in general, can also be restricted by other forms of capital and assets, such as financial resources to pay for inputs (e.g. improved seeds) or access to labour-saving technologies (e.g. power tillers, used by rich households in Kiwere). In Igingilanyi, we asked whether membership fees were an entry barrier for some households. The response was revealing: 'Irrigation requires money to produce crops, for example for inputs. Therefore if someone can't afford the entrance fee they probably also can't afford to farm' (FGD3). The same group reported a noticeable difference between those who were irrigating and those who were reliant solely on rain-fed farming, in terms of their levels of production. Thus it seems possible that better-off households largely capture the benefits of public investments in irrigation, and interventions are contributing to social differentiation (see also Mdee, 2014 on Dakawa irrigation scheme; Kissawike, 2008 on Moshi). Several studies indicate that women are often at a disadvantage in this regard (Box 7), although they are not the only marginalised group.

On the other hand, *irrigation development can provide indirect benefits to the local economy through spill-over effects*. For example, farmers in Magozi (FGD2) claimed that 'the scheme has benefited all', explaining that there was more money circulating in the community. People were able to set up small businesses and there was more employment (in the form of agricultural labour), which had reduced out-migration. This had even benefited neighbouring villages. These findings are consistent with the review of ASDP investments by Nkonya (2013), which points to the creation of jobs and new businesses, and a rise in demand for commodities and services produced by irrigation schemes. In their impact evaluation of irrigation projects in the

Box 7: Gender, land and water

The specifics on how gender relations affect participation of women in irrigation require a gender-focused approach, and were not central to our research. However, the baseline study shows that women are underrepresented in Kiwera and Magozi irrigation schemes in terms of plot ownership and participation in the WUA. In Magozi, for instance, only 100 out of 850 farmers are female (Pittock et al., 2014). In both cases, women make up less than a quarter of association members, indicating that, as a group, they have less influence on decisions made about water allocations, fees and other aspects of schemes management.

Similarly, in Moshi, Kissawike (2008) finds that women's non-participation in the relevant organisations and meetings makes it difficult for them to voice their irrigation needs and priorities. This lack of participation is attributed to the ownership of plots, which favours men, as well as the traditional belief that water management is a male domain. Moreover, female-headed households tended to be more affected by water shortages owing to patterns of occupation on the scheme (i.e. unequal access to high value plots) and inability to secure water allocations, for example through bribes.

Various studies in Tanzania indicate that women face challenges in securing irrigable land as compared with their male counterparts, which in turn limits their access to water for production. For example, research in four irrigation schemes in central Tanzania found female farmers had less access to irrigated land than men for commercial horticulture, attributing this to societal norms and institutions that privilege male ownership, particularly where resources are highly contested, such as in the drylands (Mutabazi et al., 2013; differences in access to, or control over, financial resources are also likely to play a role where land rental is on the increase). Although Tanzania has put in place progressive land laws promoting women's land rights, in practice customary tenure based on patrilineal inheritance predominates (although some areas are matrilineal) and women have little representation in land allocation decisions (Dancer, 2015).

Morogoro area, Filipinski et al. (2013) similarly conclude that such projects can generate significant indirect benefits for non-target groups, but note that the nature of these spill-over effects will depend on the structure of local markets for agricultural produce, labour mobility and the available technologies and inputs (see Mutabazi et al., 2013 for other examples).

4.4 Irrigation for climate resilience?

Irrigation is commonly viewed as a means to increase resilience in the agriculture sector, given Tanzania's dependence on climate-vulnerable rain-fed production. 'Yes, climate change is a challenge, but it is what justifies the Irrigation Commission's existence!' (Interview B). Water for crop production is a major constraint for farmers and, combined with other factors, makes small-scale agriculture a highly uncertain source of food or income. Irrigation technologies have the potential to increase and stabilise yields and bridge dry spells

(Enfors and Gordon, 2008). Nevertheless, irrigation is no panacea for achieving resilience and can, in turn, be vulnerable to climate risks (URT, 2014).

Irrigation systems are vulnerable to climate extremes, such as droughts and floods, as well as seasonal variability. This was apparent in Magozi, where farmers find floods difficult to control, damaging infrastructure, exacerbating siltation problems and destroying crops (FGD2). During our visit to the scheme large numbers of plots were inundated, delaying land preparation and planting activities.⁴⁰

During periods of drought or seasonal scarcity, irrigators are also vulnerable to water shortages. Farmers are already reporting water shortages in key irrigation areas, including in the Rufiji Basin, which are projected to see decreases in rainfall, potentially amplifying water

shortages (URT, 2014). Vulnerability to water scarcity is exacerbated where competition over resources is fierce and upstream abstractions are significant. 'Irrigation is normally the sector whose water use is restricted first during times of emergency' (Interview E). Future decreases in rainfall and increased incidences of drought will increase pressures on resources still further (Mwakalila, 2011; URT, 2014) and could have implications for allocations to the irrigation sector.

There are various ways in which climate risks to irrigation systems can be mitigated. However, *there is little evidence that climate variability and change are adequately understood and addressed in sectoral policies or project plans.*

'Sectoral development plans including the Agricultural Sector Development Strategy (ASDS), the National Irrigation Master Plan (NIMP), Kilimo Kwanza Strategy and the SAGCOT Investment Blueprint all aim to promote significant expansion of irrigated

⁴⁰ Flooding is also reported in other irrigation areas such as Morogoro and Kilombero, similarly damaging structures and crops (Interview E).

land to promote rural development. These policies, however, do not rigorously consider climate variability impacts or water availability in the design of new irrigation' (URT, 2014: 32).

'Irrigation will only increase people's resilience if you design it properly; you need to account for climate change in the design' (Interview J).

From a water management perspective, *a good starting point would be to plan for existing variability*, accepting that production will need to be scaled down in times of scarcity. Lankford and Beale (2007) suggest this could be addressed through both scheme design and water allocations, for example allowing flexibility to expand or shrink the command areas in response to water availability. The design of intakes could also be reviewed – the most commonly used designs in improved schemes take fixed volumes from the river regardless of flows, privileging upstream users and leaving downstream irrigators vulnerable (ibid.). Another method to regulate abstractions is through permitting. According to the new Water Resource Management Act (2009), water permits have to be renewed every five years. This, in

theory, allows for the review and adjustment of allocation decisions as conditions change (Interview E) – adaptive water management. A critical assumption is that basin water boards have sufficient information, political capital and human resources to make and enforce the necessary changes. However, without such responses, irrigation expansion could exacerbate risks for all water users (URT, 2014).

Although there are options to reduce risks to irrigated production, *investments in irrigation alone will not be sufficient to increase the resilience of rural livelihoods*. This point is emphasised in the ACRP, which recognises the need to safeguard natural resources and improve land and water productivity more broadly. In drought-prone areas where irrigation potential is limited, such as Igingilanyi, there is a particular need to explore alternative (or complementary) adaptation options. Enfors and Gordon (2008) study the role of supplementary irrigation in drought coping strategies in the semi-arid Same district (Kilimanjaro region). They find farmers are heavily dependent on ecosystem services when harvests fail, whereas access

to irrigation did not have any direct influence on their capacity to cope (in part because the system is overused), although participation may have indirect social benefits. The authors cautiously conclude that, while small-scale water system technologies may provide an opportunity, they need to be well designed and coordinated with other investments, while safeguarding the natural resource base.

To conclude, irrigation development may not always be a wise investment and in certain contexts can be maladaptive. Thus there are real question marks as to whether efforts to scale up irrigated agriculture can be sustainable in areas experiencing physical and/or economic water scarcity. Nor is investment in infrastructure sufficient to meet policy objectives such as poverty reduction and climate resilience. Parallel investments are needed in institutions for water management at the local and basin scales, and in bolstering agricultural markets and input supply systems. These are notable gaps in current government initiatives.

5. Conclusions and recommendations

5.1 In summary

Tanzania has a long history of traditional, or informal, irrigation constructed by smallholder farmers and managed through customary arrangements. Since the 1970s there has also been interest from the state and international donors in investing in farmer-managed irrigation, particularly to introduce modern infrastructure and formal institutions. Meanwhile, investment in large-scale commercial production has waxed and waned. At present, the government is pursuing an ambitious target to expand the irrigated areas by 1 million ha by 2016, and the irrigation sector is receiving unprecedented political profile. Consequently, investments are on the increase. After decades of neglect, this turn of events presents an exciting opportunity.

Tanzania has made significant progress in increasing national food security over the past 20 years, largely because of irrigation expansion. Nonetheless, rural poverty remains endemic and economic growth has failed to translate to social benefits. The irrigation sector itself faces a number of challenges that limit its potential to contribute to national policy objectives, such as growth and poverty reduction. These challenges are complex – the result of various technical, political and institutional factors and drivers of change, operating at multiple scales. It is important to understand these dynamics and how they shape irrigation policy, practice and performance in order to chart plausible pathways for future sector development.

In Tanzania, irrigation policies and practices have been shaped by political and ideological changes (from colonial rule to socialism, then

neoliberalism); a belief in the need to modernise smallholder production; macroeconomic crisis and the internal and external factors that contributed to this, including drought and global oil prices; political interests in winning votes and maintaining coalitions, which, for example, have served to shape import and export policies for agricultural goods; and growing interest from international players, including donors and private investors. Although climate change has not featured strongly in the political discourse surrounding irrigation *per se*, irrigation development is frequently viewed as the ‘solution’ to building resilience in the agriculture sector.

Key bottlenecks to policy implementation and performance relate to:

- Lack of political incentives to ensure stated objectives are met, weak accountability and the potential for patronage, at both national and local levels;
- A proliferation of institutions responsible for irrigation development, which hinders effective coordination, transparency and efficiency;
- A severe lack of capacity for implementation, particularly in district offices (to which responsibilities have been devolved), but also in the private sector (responsible for constructing schemes);
- The emphasis on building infrastructure, without due attention to and investment in farmer institutions for scheme management, operation and maintenance;
- Increasing competition over water, exacerbated by the absence of integrated planning

or coordination among key sectors; basin water boards, which are responsible for overseeing this, are poorly resourced and politically weak.

Numerous problems are also manifest at scheme level. Common issues reported in our case study sites, and echoed by other authors, include badly designed/built infrastructure; difficulties adapting institutions for water management and enforcing rules; limited finance for maintenance and repairs; costly inputs set against unreliable markets and low prices; and vulnerability to seasonal floods or water shortages. In future, climate change could exacerbate existing pressures on increasingly scarce resources and lead to more frequent extreme events, damaging infrastructure and/or reducing crop yields. There is an urgent need to address existing variability as well as future risks, for example in the design of irrigation systems and in the planning of resource allocations at basin level.

5.2 Future pathways for irrigation policy and practice

Improving performance in Tanzania’s irrigation sector will require a range of solutions at different scales. Some of these will be technical or managerial in nature but many relate to the political or institutional environment and are likely to be more challenging to implement. The emphasis throughout this report has been on small-scale irrigation, particularly schemes managed by farmers themselves. Although large-scale irrigation faces a slightly different set of challenges, we argue many of the fundamental building blocks to success will be the same.

Managing water across scales

In water-scarce basins, irrigation schemes pose a risk to other water users, and are themselves vulnerable to water shortages – problems that climate change is likely to exacerbate. Conflicts over water are already being experienced in the Rufiji Basin, where demand from the irrigation sector is on the increase.

At scheme level, irrigation investments need to be designed with in-built flexibility to cope with uncertainties around water supply and demand and better respond to changing circumstances, for example allowing the planned expansion and contraction of command areas. Related to this, there is a need to move away from simplistic understanding of irrigation efficiency, and to consider how efforts to increase ‘crop per drop’ at scheme level may affect other users in the basin. There is a big opportunity to change mind-sets, but this has to be done through participatory research and testing methods together with the relevant government experts. Education centres such as Sokoine University of Agriculture also have an important role to play in training the next generation of irrigation professionals.

Although support for smallholder irrigation is a political priority, to be sustainable these investments must be complemented with simple but effective measures to allocate water equitably at a sub-catchment or basin level, as well as to regulate water use. Strengthening permitting procedures and compliance monitoring is vital in this regard – the remit of the basin water boards. Nevertheless, attempts to restrict water use for agricultural production will likely meet resistance from farmers, and to date have largely been ignored.

Tanzania’s current set-up for river basin management – namely, a series of nested IWRM institutions – leaves much to be desired. On the

one hand, IWRM is relatively new to Tanzania and the relevant structures and principles have not yet become embedded in every day practices – this is a process that takes time. On the other hand, managing a basin the size of the Rufiji through the establishment of catchment committees and WUAs is likely to be an expensive endeavour and will continue to be rife with capacity challenges for the foreseeable future. There has also been a lack of political interest in prioritising water resource management over other concerns.

Basin water boards should be supported with the proper level of resources and autonomy needed to deliver their functions, as enshrined in Tanzanian law. Mobilising political support at both national and local levels will be crucial to enable them to realise their powers and sanction other actors where necessary. One means to incentivise politicians to take IWRM seriously may be to highlight the risk of inaction for the agriculture sector, and hence rural voters. MWI, which currently houses the National Irrigation Commission, could play a more proactive role in this regard.

Given the shortcomings of existing institutional arrangements, there is perhaps a need for alternative (complementary) approaches to safeguard future investments in irrigation. A critical step to identifying solutions is to establish shared understandings of water management practices, problems and goals. This can happen at ministerial level, entailing better communication between sectors, but also at the local scale, bringing together different water user groups around a specific set of issues. There have been efforts to do this in sub-catchments of the Rufiji, and hence opportunities to learn from existing experiences. Negotiating trade-offs between different interests are an inevitable part of the process and will need to be

dealt with collectively and transparently to avoid elite capture.

Attention to local institutions

Attention to smallholder institutions was found to be a significant gap in current approaches to irrigation scheme development in Tanzania. Establishing new structures for water management (which also encompass other functions such as fund generation and management) can be particularly challenging in circumstances where irrigation technologies are new and there are few existing arrangements on which to build, as in our case study sites. Yet blueprint approaches to institutional design are unlikely to work without significant local adaptation, given the diversity of socio-cultural and agro-ecological contexts in Tanzania. In any case, institutions often ‘elude design’, meaning that imposing structures on farming communities can yield mixed and unexpected results.

Social learning approaches can be a useful alternative to build the capacity of farmers and local government staff alike, but require long-term investment. Such an approach entails cycles of knowledge-sharing and joint action to co-create information, institutions and practices. Conventionally trained engineers, who predominate in Tanzania’s zonal irrigation offices and in the National Irrigation Commission, are unlikely to have the know-how to facilitate such processes. In the short term, donors and non-governmental organisations (NGOs) can provide support, in the form of technical assistance and on-the-job training, but in the longer term there is a need to recruit staff with the relevant expertise. Incorporating a stronger social component into budgets, timelines and terms of reference for irrigation projects would also incentivise consultancy companies and other private contractors to build capacity in this area, creating demand for graduates with different skill sets.

Irrigation must be profitable

Unless the state is willing (and able) to continue subsidising repairs and rehabilitation, irrigation must do more than meet farmers' subsistence needs. Irrigation is an expensive business, and will be sustainable only if it is financially lucrative. Moreover, farmers are unlikely to see the value of investing in managing and maintaining infrastructure unless they make a reasonable profit – this is an important incentive for collective action (albeit not the only one). In our case study sites, the costs of production are perceived to be relatively high when compared with market prices, and the risks of investing are considerable for farming households, given that markets are unreliable. Improving transport, storage and processing and market information systems, alongside policies to regulate market and input prices, will be necessary to make irrigation viable for these farmers. Evidence from other parts of Tanzania show that where (at least some of) these enabling conditions are in place, farmers are quick to seize opportunities for commercial horticultural production and may even invest in new technologies, such as drip irrigation, without the need for external assistance.

Ensuring benefits reach the poor and marginalised

In the rush to build new infrastructure and rehabilitate existing schemes, questions about the targeting of investments have been somewhat side-lined. High profile initiatives have tended to target districts that already have high potential, meaning that less public money goes towards semi-arid areas of Tanzania, where populations are highly vulnerable to drought. There may be opportunities to counterbalance this trend in the next iteration of the ASDP or through other government

or donor initiatives, although this may imply a reallocation of resources away from irrigation. At local level, investments should, in theory, be based on assessments of people's needs, patterns of wealth and asset ownership, agro-ecological conditions, local markets and supply chains and so forth. However, public investment decisions are often influenced by political concerns and patronage networks. Independent reviews and post-construction monitoring perhaps could help identify such malpractice and increase accountability in the irrigation sector.

Evidence from both Tanzania and Zimbabwe (see Mosello et al., 2016) suggests irrigating farmers are generally better off than non-irrigators, for example during times of drought. This raises question about who these irrigating farmers are. Access to land, water and other forms of capital can hinder participation in irrigated production, and are often barriers for marginalised groups, for example poorer households or women. These barriers are in part a product of local power relations and social norms, which can be difficult to change. Other studies in Tanzania have shown that external investments in irrigation can indeed contribute to social differentiation, reinforcing existing political economic hierarchies. Addressing constraints to participation will be crucial in tackling extreme poverty, requiring more (gender-) sensitive approaches. On the positive side, irrigation investments can have spill-over effects for the local economy, which was clear from the changes seen in standards of living in our case study sites. However, certain groups inevitably lose out; for example, use of land and water for irrigation may foreclose activities such as livestock-keeping, negatively affecting pastoral livelihoods. More research is

needed to understand the nature of these effects and trade-offs, and how more equitable outcomes might be achieved.

Improving accountability

Given the political nature of investments in irrigation, and the potential for patronage and or corruption, how can we incentivise powerful interests to take sector performance seriously? One way that decision-makers could be better held to account is through performance monitoring. Success should not be measured just in terms of canals lined or weirs built. There is a need for a clear framework to evaluate performance outcomes at both scheme and sector level, including technical and managerial aspects of performance, as well as the social, economic and environmental impacts of investments. In assessing livelihood benefits and the sector's contribution to national policy objectives, more sensible decisions can be made regarding future investments. Moreover, this information could be used to assess the performance of staff at different levels of government, with a view to shaping their incentives to deliver effective programmes and projects, as well as identifying specific capacity gaps and training needs.

Ownership of such a monitoring framework should lie with the National Irrigation Commission, which is responsible for coordinating irrigation activities in Tanzania, but other actors will also need to champion it. Donors and other development partners have an important role to play in supporting this process, funding monitoring activities and capacity-building, as well as leading by example – in other words placing a strong emphasis on long-term results in their own programmes.

References

p. 53

Annex

Institutions consulted

p. 58

References

- AgWater (2010) 'Tanzania situation analysis'. Agricultural Water Management National Situation Analysis Brief. AgWater Solutions Project, International Water Management Institute. <http://awm-solutions.iwmi.org>
- Baur, P., Mandeville, N., Lankford, B. and Boake, R. (2000) 'Upstream/downstream competition for water in the Usangu Basin, Tanzania'. Seventh National Hydrology Symposium, BHS National Hydrology Symposium Series. Newcastle: British Hydrological Symposium, University of Newcastle.
- Boss, M., Burton, M. and Molden, D. (2005) *Irrigation and Drainage Performance Assessment: Practical Guidelines*, Wallingford, UK: CABI Publishing
- De Bont, C., Veldwisch, G.J., Komakech, H.C. and Vos, J. (2015) 'The fluid nature of water grabbing: The on-going contestation of water distribution between peasants and agribusinesses in Nduruma, Tanzania', *Agriculture and Human Values* 33(3): 641–54.
- Booth, D., Cooksey, B., Golooba-Mutei, F. and Kanyinga, K. (2014) 'East Africa prospects: An update on the political economy of Kenya, Rwanda, Tanzania and Uganda'. ODI Report. London: ODI.
- Calow, R. and Mason, N. (2014) *The real water crisis: Inequality in a fast changing world*. London: ODI.
- Chaponnière, A., Marlet, S., Bouleau, G. and Perret, S.R. (2012) 'Methodological pathways to improvements of evaluation approaches: The case of irrigated agriculture evaluation', *Journal of Multidisciplinary Evaluation* 8(18): 47–57.
- Charnley, S. (1991) 'Ethnicity and the commons: Problems of rangeland management in an inter-ethnic context'. Paper presented at the Second Annual Conference of the International Association for the Study of Common Property, Winnipeg, 26–29 September.
- Chiroro, C. (2015) 'Innovations to promote growth in small-scale irrigation in Africa: Malawi report'. Report for the DFID Growth Research Program, led by the School of Global Studies, University of Sussex.
- Chiza, C.K. (2005) 'The role of irrigation in agriculture, food security and poverty reduction'. Paper presented at the 3rd Annual Engineer's Day, 2005–Learned Discourse, Dar es Salaam, 14–15 March.
- CIA (Central Intelligence Agency) (2016) 'Tanzania', World Factbook, accessed 4 July 2016. www.cia.gov/library/publications/the-world-factbook/geos/tz.html
- Cooksey, B. (2013) *What difference has CAADP made to Tanzanian agriculture?* Working Paper 2013. Brighton: FAC.
- Coulson, A. (2010) *Kilimo Kwanza: A new start for agriculture in Tanzania?* Birmingham: Institute of Local Government Studies, University of Birmingham.
- Coulson, A. (2015) 'Small-scale and large-scale agriculture: Tanzanian experiences', in M. Stahl (ed.) *Looking back, looking ahead – land, agriculture and society in East Africa*. Stockholm: Nordic Africa Institute.
- Coulson, A. and Diyamett, B. (2012) *Improving the contribution of agricultural research to economic growth: Policy implications of a scoping study in Tanzania*. Working Paper F-40009-TZA-1. London: IGC.
- Dancer, H. (2015) 'Realising women's land rights: Law, gender and farming in Tanzania', *Future Agricultures Blog*, 3 August. www.future-agricultures.org/blog/entry/realising-women-s-land-rights-law-gender-and-farming-in-tanzania
- Davis, R. and Hirji, R. (2015) *Climate change and water resources planning, development and management in Zimbabwe*. Harare: World Bank and Government of Zimbabwe.
- Deressa, T.T., Hassan, R.M., Ringler, C., Alemu, T. and Yesuf, M. (2009) 'Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia', *Global Environmental Change* 19 (2): 248–55.
- Enfors, E.I. and Gordon, L.J. (2008) 'Dealing with drought: the challenge of using water system technologies to break dryland poverty traps', *Global Environmental Change* 18: 607–16.
- Evans, A.E.V., Giordano, M. and Clayton, T. (2012) *Investing in agricultural water management to benefit smallholder farmers in Tanzania, AgWater Solutions Project country synthesis report*. Working Paper 146. Colombo: IWMI.
- FAO (Food and Agriculture Organization) (2005) 'AQUASTAT website', http://www.fao.org/nr/water/aquastat/countries_regions/tza/index.stm, accessed 7 August 2016.
- FAO (Food and Agriculture Organization) (2011) *The state of the world's land and water resources for food and agriculture: Managing systems at risk*. New York: Earthscan.
- Faurès, J., Svendsen, M., Turrall, H., Berkhoff, J. et al. (2007)

- 'Reinventing irrigation', in D. Molden (ed.) *Water for food, water for life: A comprehensive assessment of water management in agriculture*. London and Colombo: Earthscan and IWMI.
- Filipski, M., Manning, D., Taylor, J.E., Diao, X. and Pradesha, A. (2013) *Evaluating the local economy wide impacts of irrigation projects: Feed the Future in Tanzania*. Discussion Paper 01247. Washington, DC: IFPRI.
- Fischer, G., Tubiello, F.N., Velthuisen, H.V. and Wiberg, D.A. (2007) 'Climate change impacts on irrigation water requirements: Effects of mitigation, 1990–2080', *Technological Forecasting and Social Change* 74(7): 1083–1107.
- Forss, K., Marra, M. and Schwartz, R. (eds) (2011) *Evaluating the complex: Attribution, contribution, and beyond*. Vol. 1. New Brunswick and London: Transaction Publishers.
- Franks, T., Lankford, B. and Mdemu, M. (2004) 'Managing water amongst competing uses: The Usangu Wetland in Tanzania', *Irrigation and Drainage* 53: 277–86.
- Frenken, K. (2005) *Irrigation in Africa in figures: AQUASTAT Survey – 2005*. FAO Water Reports 29. Rome: Land and Water Development Division, FAO.
- Friis, C. and Reenberg, A. (2010) *Land grab in Africa: Emerging land system drivers in a teleconnected world*. Global Land Project Report 1. Copenhagen: GLP-IPO.
- Funk, C., Dettinger, M.D., Brown, M.E. and Barlow, M. (2008) 'Warming of the Indian Ocean threatens Eastern and Southern African food security but could be mitigated by agricultural development', *Proceedings of the National Academy of Sciences* 105: 11081–6.
- GCAP (Global Climate Adaptation Partnership) (2011) *The economics of climate change in the United Republic of Tanzania*. Oxford: GCAP.
- Gray, R.F. (1963) *The Sonjo of Tanganyika: An anthropological study on an irrigation-based society*. Oxford: Oxford University Press.
- Harris, D. (2013) *Applied political economy analysis: A problem driven framework*. London: ODI.
- Howarth, S., Nott, G., Parajuli, U. and Dzhalobayev, N. (2007) 'Irrigation, governance and water access: Getting better results for the poor'. Paper presented at the 4th Asian Regional Conference and 10th International Seminar on Participatory Irrigation Management, Tehran, 2–5 May.
- Hyden, G. (2008) 'Ujamaa, villagisation and rural development in Tanzania', *Development Policy Review* A8(1): 53–72.
- Ibhawoh, B. and Dibua, J.I. (2003) 'Deconstructing Ujamaa: The legacy of Julius Nyerere in the quest for social and economic development in Africa', *African Journal of Political Science* 8(1): 59–83.
- ICID (International Commission on Irrigation and Drainage) (2012) 'Tanzania Country Profile', accessed 25 September 2016. www.icid.org/cp_tanzania.html
- Ikeno, J. (1992) 'Tanzania agriculture under the structural adjustment programmes, with special reference to two villages in Kilimanjaro Region', in T. Haraguchi (ed.) *African political economy in transition*. Africa Research Series 5. Tokyo: Institute of Developing Economies.
- Ikeno, J. (2011) 'Dry-season irrigation farming at the western foot of the North Pare Mountains, Tanzania', *African Study Monographs* Suppl.42: 59–77.
- Isinika, A.C., Ashimogo, G.C. and Mlangwa, J.E.D. (2003) 'Tanzania macro study: Final research report'. Africa in Transition research programme, Sokoine Agricultural University, Morogoro.
- Issar, A.S. and Adar, E. (2010) 'Progressive development of water resources in the Middle East for sustainable water supply in a period of climate change', *Philos Transact A Math Phys Eng Sci* 368(1931): 5339–50.
- JICA (Japan International Cooperation Agency) (2002) *The study on the national irrigation master plan in the United Republic of Tanzania*. Dar es Salaam: JICA and MAFC.
- Kadigi, R.M.J., Tesfay, G., Bizoza, A. and Zinabou, G. (2012) 'Irrigation and water use efficiency in Sub-Saharan Africa'. Agriculture Policy Briefing Paper 4. Washington, DC: GDN.
- Kamau, J. (2015) 'Tanzania: The fall and rise of Tanzania's Kilombero, and Tom Mboya's fears over Kenya sugar firms', Daily Nation, 31 August. <http://allafrica.com/stories/201509010404.html>
- Kelsall, T. (2013) *Business, politics and the state in Africa: Challenging orthodoxies on growth and transformation*. London: Zed Books.
- Kissawike, K. (2008) 'Irrigation-based livelihood challenges and opportunities: A gender technographic study of irrigation development intervention in the Lower Moshi Irrigation Scheme in Tanzania'. PhD dissertation, Wageningen University.
- Kuusi, S. (2009) 'Aspects of local self-government: Tanzania'. North-South Local Government Co-operation Programme, The Association of Finnish Local and Regional Authorities.
- Kurukuklasuriya, P., Mendelsohn, R., Hassan, R., Benhin, J. et al. (2006) 'Will African agriculture survive climate change?' *The World Bank Economic Review* 20(3): 367–88.

- Lankford, B.A. (2004) 'Irrigation improvement projects in Tanzania: scale impacts and policy implications', *Water Policy* 6(2): 89–102.
- Lankford, B.A. (2009) 'The right irrigation? Policy directions for agricultural water management in Sub-Saharan Africa', *Viewpoint, Water Alternatives* 2(3): 476–80.
- Lankford, B. (2012) 'Fictions, fractions, factorials and fractures: On the framing of irrigation efficiency', *Agricultural Water Management* 108: 27–38.
- Lankford, B.A. and Beale, T. (2007) 'Equilibrium and non-equilibrium theories of sustainable water resources management: dynamic river basin and irrigation behaviour in Tanzania', *Global Environmental Change* 17(2): 168–80.
- Lankford, B. and Franks, T. (2000) 'The sustainable coexistence of wetlands and rice irrigation: a case study from Tanzania', *Journal of Environment and Development* 9(2): 119–37.
- Lankford, B.A., van Koppen, B., Franks, T. and Mahoo, H. (2004) 'Entrenched views or insufficient science? Contested causes and solutions of water allocation – insights from the Great Ruaha River basin, Tanzania', *Agricultural Water Management*, 69(2) 135–53.
- Lufunyo, H. (2013) 'Impact of public sector reforms on service delivery in Tanzania', *International Journal of Social Science Tomorrow* 2(2): 1–26.
- MacDonald, A.M., Bonsor, H.C., Dochartaigh, B.É.Ó. and Taylor, R.G. (2012) 'Quantitative maps of groundwater resources in Africa', *Environmental Research Letters* 7: 1–7.
- MAFC (Ministry of Agriculture, Food Security and Cooperatives) (2016) 'Our mission', accessed 24 September 16. <http://www.kilimo.go.tz/>
- Maganga, F.P., Butterworth, J.A. and Moriarty, P. (2002) 'Domestic water supply, competition for water resources and IWRM in Tanzania: a review and discussion paper', *Physics and Chemistry of the Earth* 27: 919–26.
- Manneh, B., Kiepe, P., Sie, M., Ndjiondjop, M. et al. (2007) 'Exploiting partnerships in research and development to help African rice farmers cope with climate variability', *Journal of SAT Agricultural Research* 4(1). e-journal published by ICRISAT.
- Matari E.R., Chang'a L.B., Chikojo G.E. and Hyera T. (2008) 'Climate change scenario development for Second National Communication – Tanzania', *TMA Research Journal* 1: 40–54.
- Matekere E. and N. Lema (2012) 'Performance analysis of public funded irrigation projects in Tanzania', *Irrigation and Drainage Systems* 25(4): 237–53.
- McSweeney, C., New, M. and Lizcano, G. (2010) *Tanzania*. UNDP Climate Change Profile. Oxford: School of Geography and Environment, University of Oxford.
- Mdee, A., with Harrison, E., Mdee, C., Mdee, E. and Bahati, E. (2014) *The politics of small-scale irrigation in Tanzania: Making sense of failed expectations*. Working Paper 107. Brighton: FAC.
- Mdemu, M. and Mziray, N. (2014) 'Profiles and situation report for Magozi and Kiwere irrigation schemes'. Report for Increasing Irrigation Water Productivity in Mozambique, Tanzania and Zimbabwe through On-Farm Monitoring, Adaptive Management and Agricultural Innovation Platforms for the Australian Centre for International Agricultural Research.
- Mdemu M.V., Magayane M.D., Lankford B., Hatibu N. and Kadigi R.M.J. (2004) 'Conjoining rainfall and irrigation seasonality to enhance productivity of water in rice irrigated farms in the Upper Ruaha River Basin, Tanzania', *Physics and Chemistry of the Earth* 29(15-18): 1119–24.
- Mendelsohn, R. and Seo, N. (2007) *Changing farm types and irrigation as an adaptation to climate change in Latin American agriculture*. Policy Research Working Paper. Washington, DC: World Bank.
- Merrey, D.J., Meinzen-Dick, R., Mollinga, P.P., Karar, E. et al. (2007) 'Policy and institutional reform: The art of the possible', in D. Molden (ed.) *Water for food, water for life: A comprehensive assessment of water management in agriculture*. London and Colombo: Earthscan and IWMI.
- Meredith, N. (2005) *The fate of Africa: A history of fifty years of independence*. New York: Public Affairs.
- Mosello, B., Oates, N. and Jobbins, G. (2016) 'Pathways for irrigation development: politics, policies and irrigation performance in Zimbabwe'. PRISE Report. London: ODI.
- Mutabazi, K., Wiggins, S. and Mdoe, N. (2013) *Commercialisation of African smallholder farming. The case of smallholder farmers in central Tanzania*. Working Paper 72. Brighton: FAC.
- Mwakalila, S. (2011) 'Vulnerability of people's livelihoods to water resources availability in semi-arid areas of Tanzania', *Journal of Water Resources and Protection* 3: 678–85.
- Mwalyosi, R.B.B. (1990) 'Resource potentials of the Rufiji River Basin, Tanzania', *Ambio* 19(1): 16–20.
- Ngaiza, R. (2012) 'Tanzania smallholder policy: Kilimo Kwanza'. Presentation at FAO–University of Nairobi Regional Workshop on an Integrated Policy Approach to Commercialising Smallholder Maize Production, Nairobi, 6–7 June.
- Neumann, K., Stehfest, E., Verburg, P.H., Siebert, S. et al. (2011) 'Exploring global irrigation patterns:

A multilevel modelling approach', *Agricultural Systems* 104(9): 703–13.

Nkonya, E. (2013) 'Impact evaluation of the irrigation investment of the Agricultural Sector Development Program (ASDP)'. Report submitted to MAFC, JICA, USAID and World Bank.

Oates, N., Jobbins, G., Mosello, B. and Arnold, J. (2015) *Pathways for irrigation development in Africa – insights from Ethiopia, Morocco and Mozambique*. Working Paper 119. Brighton: FAC.

Oates, N., Hisberg, A., Rodriguez Ros, J., Solomon, H. et al. (forthcoming) 'The implications of state intervention for self-governed irrigation: Insights from Tigray, Ethiopia' *Irrigation and Drainage*.

Patel, S., Vedeld, P. and Tarimo, A. (2014) *Irrigation management, institutions and local livelihood adaptation on Usangu plains, Tanzania*. Noragric Working Paper 49. Asas: Faculty of Social Sciences, Norwegian University of Life Sciences.

Pavelic, P., Villholth, K.G., Shu, Y., Rebelo, L.-M. and Smakhtin, V. (2013) 'Smallholder groundwater irrigation in Sub-Saharan Africa: country-level estimates of development potential', *Water International* 38(4): 392–407.

Pereira, L.S., Oweis, T. and Zairi, A. (2002) 'Irrigation management under water scarcity', *Agricultural Water Management* 57(3): 175–206.

[Pittock, J., Grafton, P. and White, C. \(2014\) *Water, Food and Agricultural Sustainability in Southern Africa*, Tilde University Press, Prahran, Vic.](#)

Rhodes, J., Bjornlund, H. and Wheeler, S. (2014) 'Project baseline report'. Increasing Irrigation Water Productivity in Mozambique, Tanzania and Zimbabwe through On-Farm Monitoring, Adaptive Management and Agricultural Innovation

Platforms, University of South Australia.

SAGCOT (Southern Agricultural Growth Corridor of Tanzania) Centre (2015) 'Who we are', Brochure, May.

Sakaki, M. and Koga, K. (2011) 'An effective approach to sustainable small-scale irrigation developments in Sub-Saharan Africa', *Paddy and Water Environment* 11(1–4): 1–14.

Smith, L.E. (2004) 'Assessment of the contribution of irrigation to poverty reduction and sustainable livelihoods', *International Journal of Water Resources Development* 20(2): 243–57.

Tagseth, M. (2008) 'The Expansion of Traditional Irrigation in Kilimanjaro, Tanzania', *International Journal of African Historical Studies* 41(3): 461–490.

The Montpellier Panel (2012) *Growth with resilience: Opportunities in African agriculture*. London: Agriculture for Impact.

Therkildsen, O. (2011) *Policy making and implementation in agriculture: Tanzania's push for irrigated rice*. Working Paper, 2011:26. Copenhagen: DIIS.

Trading Economics (2016) 'Tanzania GDP annual growth rate', accessed 4 July 2016. www.tradingeconomics.com/tanzania/gdp-growth-annual

Tubiello, F.N. and van der Velde, M. (2012) 'Land and water use options for climate change adaptation and mitigation in agriculture'. State of the World's Land and Water Resources for Food and Agriculture Background Thematic Report: TR04A. Rome: FAO.

UNDP (United Nations Development Programme) (2015) *2015 Human Development Report: Work for human development*. New York: UNDP.

URT (United Republic of Tanzania) (1997) *National Environmental Policy*. Dar es Salaam: VPO.

URT (1999) *The Tanzania Development Vision 2025*. Dar es Salaam: Planning Commission.

URT (2001) *Agriculture Sector Development Strategy*. Dar es Salaam: URT.

URT (2002) *National Water Policy*. Dar es Salaam: Ministry of Water and Livestock Development.

URT (2004) *Environmental Management Act 2004*. Dar es Salaam: URT.

URT (2005) *Water Sector Development Programme (2005-2015)*. Dar es Salaam: Ministry of Water.

URT (2006a) 'Agriculture Sector Development Programme (ASDP): Support through Basket Fund'. Government Programme Document. Dar es Salaam: URT.

URT (2006b) *National Water Sector Development Strategy (2006-2015)*. Dar es Salaam: MWI.

URT (2007) *National Adaptation Programme of Action (NAPA)*. Dar es Salaam: DoE, VPO.

URT (2009a) *Water Resources Management Act 2009*. Dar es Salaam: URT.

URT (2009b) *National Rice Development Strategy*. Dar es Salaam: MWI.

URT (2009c) *The Kilimo Kwanza (Agricultural First) Resolution*. Dar es Salaam: MWI.

URT (2009d) *National Public-Private Partnerships Policy*. Dar es Salaam: Prime Minister's Office.

URT (2010a) *National Irrigation Policy*. Dar es Salaam: MWI.

URT (2010b) *National Strategy for Growth and Reduction of Poverty 2*. Dar es Salaam: Ministry of Finance and Economic Affairs.

URT (2011a) *SAGCOT investment blueprint*. Dar es Salaam: SAGCOT.

URT (2011b) *Tanzania Agriculture and Food Security Action Plan 2011-12 to 2020-21*. Dar es Salaam: MAFC.

- URT (2011c) 'Evaluation of the performance and achievements of the ASDP', second draft, April, submitted to the Director of Planning and Policy, MAFC.
- URT (2012) *National Climate Change Strategy*. Dar es Salaam: DoE, VPO.
- URT (2013a) *National Strategy for Reduced Emissions from Deforestation and Forest Degradation (REDD+)*. Dar es Salaam: Vice President's Office.
- URT (2013b) *National Agriculture Policy*. Dar es Salaam: MAFC.
- URT (2013c) *National Irrigation Act 2013*. Dar es Salaam: URT.
- URT (2013d) *Agriculture Sector Development Strategy*. Dar es Salaam: URT.
- URT (2014) *Agriculture Climate Resilience Plan*. Dar es Salaam: MAFC.
- URT (n.d.) *Tanzania Development Mission 2025, Big Results Now! Roadmap*. Dar es Salaam: President's Delivery Bureau.
- Wambura, F., Tumbo, S., Ngongolo, H., Mlonganile, P. and Sangalugembe, C. (2014) 'Tanzania CMIP5 Climate Change Projections'. Proceedings of the International Conference on Reducing Climate Change Challenges through Forestry and Other Land Use Practice.
www.taccire.suanet.ac.tz/xmlui/handle/123456789/460
- Wiggins, S. and Leturque, H. (2010) *Helping Africa to feed itself: Promoting agriculture to reduce poverty and hunger*. Occasional Paper 002. Brighton: FAC.
- Woodhouse, P. and Ganho, A.S. (2011) 'Is water the hidden agenda of agricultural land acquisition in sub-Saharan Africa?' Paper presented at the conference Global Land Grabbing, 6-7 April 2011, Brighton, UK: Institute of Development Studies, University of Sussex
- World Bank (2013) *Tanzania agricultural sector risk assessment*. Dar es Salaam: World Bank.
- World Bank (2016) 'Tanzania overview', accessed 4 July 2016.
www.worldbank.org/en/country/tanzania/overview
- Yanda, P., Mushi, D., Henku, A.I., Maganga, F. et al. (2013) 'Tanzania national climate change finance analysis'. ODI Report. London: ODI.
- Yoshida, M. (1985) 'Traditional furrow irrigation system in the South Pare Mountain area of Tanzania', in A. Mascarenhas, J. Ngana and M. Yoshida (eds) *Opportunities for irrigation dry-season irrigation farming at the western foot of the North Pare Mountains, Tanzania*. Tokyo: Institute of Developing Economies.
- You, L.Z. (2008) *Irrigation investment needs in sub-Saharan Africa*. Africa Infrastructure Country Diagnostic Background Paper 9. Washington, DC: World Bank.
- You, L.Z, Ringler, C., Wood-Sichra, U., Robertson, R., Wood, S., Zhu, T., Nelson, G., Guo, Z., and Sun, Y. (2011) 'What is the irrigation potential for Africa? A combined biophysical and socioeconomic approach', *Food Policy*, 36(6): 770–782.
- Zhou, Y., Zwahlen, F., Wang, Y. and Li, Y. (2010) 'Impact of climate change on irrigation requirements in terms of groundwater resources', *Hydrogeology Journal* 18(7): 1571–82.
- Ziervogel, G., Bharwani, S. and Downing, T.E., (2006) 'Adapting to climate variability: Pumpkins, people and policy', *Natural Resources Forum* 30(4): 294–305.

Annex: Institutions consulted

Institutions consulted
Ardhi University
National Irrigation Commission
Platform for Agricultural Policy Analysis and Coordination
Big Results Now
Ministry of Water and Irrigation
International Fund for Agricultural Development
Iringa District Agricultural Office
Rufiji Basin Water Board
Worldwide Fund for Nature
Water and Environmental Management Consultants
Department for International Development
Division of Environment, Vice-President's Office
International Union for Conservation of Nature
Southern Agricultural Growth Corridor of Tanzania Centre
Farmers from Kiwere irrigation scheme (Iringa district)
Farmers from Magozi irrigation scheme (Iringa district)
Farmers from Igingilanyi irrigation scheme (Iringa district)

PRISE

Overseas Development Institute
203 Blackfriars Road
London SE1 8NJ
United Kingdom

Tel. +44 (0)20 7922 0438

www.prise.odi.org

Research for climate-resilient futures

This work was carried out under the Collaborative Adaptation Research Initiative in Africa and Asia (CARIAA), with financial support from the UK Government's Department for International Development (DfID) and the International Development Research Centre (IDRC), Canada. The views expressed in this work are those of the creators and do not necessarily represent those of DfID and IDRC or its Board of Governors.

With funding from:



Australian Government

**Australian Centre for
International Agricultural Research**

**Australian
Aid** 



CARIAA
*Collaborative Adaptation Research
Initiative in Africa and Asia*



IDRC | CRDI

International Development Research Centre
Centre de recherches pour le développement international

Canada 