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How do sectoral policies support climate compatible development? An empirical analysis focusing on southern Africa

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ABSTRACT

Promoting inclusive and sustainable economic and social development whilst simultaneously adapting to climate change impacts and mitigating greenhouse gas emissions – Climate Compatible Development (CCD) – requires coherent policy approaches that span multiple sectors. This paper develops and applies a qualitative content analysis to assess national sector policies of ten southern African countries to determine their approaches for water, agriculture, forestry and energy and their compatibility with the aims of the three dimensions of CCD (development, climate adaptation and climate mitigation). Results indicate that sector policies currently only partially support shifts towards CCD, with approaches that both complement and detract from CCD being prioritized by national governments. Agriculture offers the greatest number of potentially viable approaches capable of achieving the development, adaptation and mitigation aims inherent in CCD, while energy the least. National governments should focus on developing coherent, cross-sector approaches that deliver such potential triple wins in order to promote new forms of inclusive and sustainable economic and social development, whilst facilitating adaptation to climate change impacts and supporting mitigation activities. Doing so will also go a long way towards ensuring the progress needed for achieving the Sustainable Development Goals (SDGs) and Nationally Determined Contributions (NDCs) to the Paris Climate Agreement.

1. Introduction

Following the adoption of the two latest milestones of international governance, i.e. the Paris Agreement and the Sustainable Development Goals (SDGs), the world is faced anew with the multi-faceted and interconnected challenge of promoting inclusive and sustainable economic and social development, whilst adapting to the impacts of climate change and mitigating against further warming. Importantly, the SDGs will require transformative action precisely because of the need for climate change to be mainstreamed and integrated in all aspects of development work (Maxwell, 2017). The requisite level of ambition is prescribed by the Paris Agreement.

A key motivation for promoting flexible and transformative climate action is the identification of developing countries in Africa and elsewhere as particularly vulnerable to the impacts of climate change (IPCC, 2014). In recent years their number of experiences of significant climate shocks (notably floods and droughts) has multiplied and is perilously projected to only go in one direction: up. Extreme weather and the accompanying threats could potentially cancel the significant progress that these countries have made in poverty alleviation, agricultural productivity, disease control and malnutrition reduction (IPCC, 2014). Put differently, recent development gains are dangerously fragile, given they have been made in climate-sensitive sectors (CDKN, 2015), hence, the increased recognition of the imperativeness of incorporating climate policy into other policy sectors (Stringer et al., 2014).

Obviously, integrating climate policy and development goals is not a recent idea, going all the way back to the UNFCCC's (United Nations Framework Convention on Climate Change) identification of the complementarities between mitigation, adaptation and sustainable development. However, exploration of synergies between climate change and development goals only gained traction during the 2000s, as evidenced by the widespread deployment of, and experimentation with, a number of operational concepts, such as 'low carbon development', 'climate resilient development', 'co-benefits' and others (Nunan, 2017).

While the literature has offered a wide assortment of terminology, perhaps the most developed model is that of Climate Compatible Development (CCD), which seeks 'triple wins' and has thus been defined as 'development that minimizes the harm caused by climate impacts, while maximizing the many human development opportunities

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presented by a low emissions, more resilient future' (Mitchell and Maxwell, 2010, p. 1).

CCD is a relatively recent concept (c. 2010) and despite increasing policy support for it (e.g. Stringer et al., 2014), progress in moving towards CCD in practice, both within and across sectors, has not yet been explored in depth. Discussions in the literature have so far explored *inter alia* the drivers of CCD (Ellis et al., 2003), the potential impacts of CCD interventions (Suckall et al., 2015), as well as their implications for procedural justice (Wood et al., 2016). There is, however, pressing need for evidence-based empirical case studies analysing the interactions between adaptation, mitigation and development (Tompkins et al., 2013). Most commonly, adaptation and mitigation have been examined in the absence of development, although examples of case study research that identify the ability to provide potential 'triple-wins' for each of adaptation, mitigation and development are gradually emerging (e.g. Klein et al., 2007; Ellis et al., 2003; Suckall et al., 2015).

Synthesising lessons from the first seven years' experience with the concept of CCD, Maxwell (2017) acknowledges the breakthroughs in the understanding of how CCD can be operationalised in practice but posits that several challenges need still to be overcome if the concept is to gain traction with policymakers in developing countries. Prime among these is the need for eliminating ambiguity in the concept of CCD by exploring complementarities and tensions so as to 'tackle low awareness and poor information on uncertainties, risks, opportunities and trade-offs' (Tanner et al., 2014, p. 6). Stringer et al. (2017) have noted that policymakers regard the integrative template that CCD offers as useful when reviewing development policies, providing a reminder to actively place climate change at the centre of cross-sectoral and inter-ministerial discussions. However, concern has been concurrently expressed that adoption of the CCD concept stumbles upon the lack of concrete examples of 'triple wins', as well as of trade-offs (Nunan, 2017).

Adding to the empirical evidence base of 'triple-win' projects is consequently particularly important for natural resource based sectors that are most sensitive to climate change, and which support the livelihoods of millions of people globally. This paper targets this gap by focusing on national sector policies in southern Africa. In particular, it assesses policies from the water, agriculture, energy and forestry sectors and examines their potential to move towards CCD by analysing their alignment with CCD's three component parts: adaptation, mitigation and development. Different sectors of national policy making can address the priorities for adaptation, mitigation and development in different ways. While energy and forestry sectors are typically considered at the forefront of mitigation options, agriculture and water are generally considered to require more of an adaptation focus (IPCC, 2014; Klein et al., 2007). Understanding how different sectors handle the components of CCD is important in identifying scope for conflicts and mutual benefits between policy areas, as well as opportunities for harnessing benefits capable of supporting shifts towards enhanced climate adaptation, mitigation and development, within and across sectors.

This paper, therefore, contributes towards understanding how CCD 'triple wins' can be pursued and trade-offs reduced; an area that remains underexplored, with a dearth of assessments that examine possibilities to achieve CCD across different natural resource based sectors. By carrying out a cross-sectoral comparison of government policy documents, this paper aims to address the question of how national governments can harmonize their national policies in order to maximize their potential to move towards CCD. It therefore provides important insights that can help address some of these challenges around operationalising in practice CCD in southern Africa.

2. Research design and methods

Our research design and methodological approach is developed from the framework used by Tompkins et al. (2013) and involves qualitative content analysis of SADC (Southern Africa Development Community) countries' national sector policies to determine their priority approaches for water, agriculture, forestry and energy. Approaches were assessed according to whether and how they contribute towards the three components of CCD (adaptation, mitigation and development).

National policies for water, agriculture, forestry and energy in ten Anglophone SADC countries (Botswana, Lesotho, Malawi, Mauritius, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe) were chosen as the focus in order to understand government priorities for each sector in relation to the three components of CCD.[1] National policies were developed by governments to provide overall direction, objectives and management strategies for environmental sectors. We did not restrict the timeframe of our analysis as some countries have not updated their policies recently. Internet searches were conducted in order to locate the sector policies on government and other relevant websites. For policies that could not be located online, staff members working for relevant government departments were contacted by email in order to obtain the policies (full list of analysed policies given in Supplementary material Table 1).

Qualitative content analysis was used to facilitate impartial analysis of written documents, including policies (Altheide et al., 2008; Bowen, 2009), and was carried out to determine the priorities in water, agriculture, forestry and energy sector policies. Given the multitude of policies outlined in these documents for each of the four sectors per country, only the ones that were emphasized upon the most were selected. Textual terminology and positioning was used to determine the emphasis of one approach relative to another, with identification of emphasis based on whether a specific approach was noted in the relevant policy document as being a 'top priority', of 'particular focus', 'urgent', an 'important consideration' or a 'main policy objective'. The entire content of the policies were read in order to determine emphasis, with the keywords relating to the approaches being searched for within each policy document.

To determine policy alignment with the three CCD components each of the priority approaches was assessed on its potential ability to positively and/or negatively contribute to the three components of CCD, following Tompkins et al. (2013). The identified priority approaches within each of the four sector policies for each study country were then scored according to the criteria in Table 1. Note here that we aim for a qualitative analysis of 'triple-wins' in the three sectors and not for a quantitative assessment of adaptation, mitigation and development aspects.

Each priority approach was coded once, based upon its specific theme within the policy in which it was named (water, agriculture, energy or forestry policy), then subjectively assessed regarding the potential benefits (often termed 'wins') and potential negative impacts (or 'losses') for climate adaptation, mitigation and development at a national level. In this manner, each of the priority approaches for the ten countries was systematically coded and entered into a table, ensuring consistency and validity across sector policies. Each approach was then coded with regards to the assessment criteria detailed in Table 1. For example, if an approach contributed to potential wins for adaptation, mitigation and development with no negative consequences for each, then it was assigned a score of four. If an approach contributed to two components of adaptation, mitigation or development and had no negative consequences for each component, it was assigned a score of three. If an approach contributed to adaptation, mitigation and development but had negative consequences for one or more of the components, it was assigned a score of two (see Lesotho water policy example below). A score of one, potential double wins with regrets, was

[1] Only national policies written in English were considered within the selected countries where the language of government is English.

Table 1
Classification scheme of approaches that align with the three main components of CCD (adapted from Tompkins et al., 2013).

Tier	Balance of positives and negatives for CCD components	Assessment score
1	Triple wins with no regrets	4
2	Double wins with no regrets	3
3	Triple wins with regrets	2
4	Double wins with regrets	1

Table 2
Assessment scores for the overall net effect of sector approaches in relation to CCD based on scoring criteria outlined in Table 1.

	Water	Agriculture	Forestry	Energy	Mean score for country
Botswana	3.00	3.00	2.60	2.00	**2.65**
Lesotho	2.50	2.50	3.00	2.25	**2.56**
Malawi	2.42	2.57	1.50	2.40	**2.22**
Mauritius	2.80	1.83	3.00	2.60	**2.55**
Namibia	2.75	2.80	2.50	2.50	**2.63**
South Africa	2.75	3.25	2.75	2.60	**2.83**
Swaziland	2.60	2.75	3.00	2.40	**2.68**
Tanzania	2.37	3.28	2.33	2.16	**2.53**
Zambia	2.30	2.75	2.75	2.16	**2.49**
Zimbabwe	2.00	2.66	2.75	2.25	**2.41**
Mean score for sector	**2.55**	**2.73**	**2.62**	**2.33**	

The bold values are mean averages.

assigned to approaches that contributed to two components of adaptation, mitigation or development with potential losses for one or more of the three components. Assumptions are detailed in Supplementary material Table 2 and seek to contextualize the assessment of the potential wins and losses identified in relation to each component of CCD.[2]

For example, Lesotho's national water policy prioritizes the expansion of water infrastructure including multi-purpose reservoir construction with hydropower which provides both potential wins and losses for each of adaptation, mitigation and development. Flood management and increased water storage strengthens adaptation potential if rainfall levels become more variable; for mitigation, hydropower reduces carbon dioxide emissions; and for development, increased water storage will improve water availability for drinking, irrigation, industrial requirements and provide electricity from hydropower. Concerning potential negative impacts of this water policy priority, mitigation losses include the destruction of ecosystem habitat and potential carbon sequestration potential from the land area that is flooded during reservoir construction, as well as emissions from rotting vegetation in the reservoir area; and potential development losses include the displacement of individuals and communities from the land flooded (IPCC, 2014).

The assumptions for this assessment are that the land area flooded is inhabited by humans and is covered by ecosystems that have carbon sequestration value. With regards to how future climate change scenarios were considered in the scoring system, it was assumed that temperature will rise, and that the level of inter- and intra-annual precipitation could either increase or decrease in time and space over future years and decades, in line with IPCC regional projections for southern Africa (IPCC, 2014).

To identify the net effect of the sector approaches in relation to CCD, a mean assessment score of the policy approaches for each sector was calculated, followed by a mean score for the ten sampled SADC countries (Section 3.1). To examine the four sector approaches in relation to the three components of CCD, the balance of potential wins and losses or regrets for each CCD component was calculated for each approach and expressed as a percentage, then calculated for each sector with regards to the balance across each of the three CCD components (section 3.2). In this way, the ability of sectors to meet the needs of both adaptation and mitigation was examined. Such an exercise has not been carried out before for sectoral policy approaches relating to water, agriculture, forestry and energy within the SADC region and is an important guide to the forward planning of other sub-Saharan African states.

3. Results

Numerous approaches were classified as offering potential 'triple wins with no regrets', the most direct pathways towards implementing CCD, by enabling policy advances to support each of climate adaptation, mitigation and development. These include water demand management (e.g. irrigation efficiency measures), agroforestry and community-based forest management. Other approaches scored lower owing to the balance of trade-offs (potential benefits (wins)) and potential losses (regrets) between adaptation, mitigation and development. Examples of these included fossil fuel based energy generation, increased application of fertilisers and pesticides, inter-basin water transfer and livestock breeding.

First, the overall net effect of the sector approaches on CCD for each SADC country is set out; second, the alignment of sector approaches with individual CCD components is shown.

3.1. Overall net effect of sector approaches on CCD

Table 2 highlights both means, as well as ranges of scores for the sectors and countries under study. Starting with the former, mean assessment scores vary between countries, as well as between the agriculture, water, forestry and energy sectors. That there are only small differences between scores is unsurprising given that each country has a National Development Plan or equivalent which acts as an overarching framework to guide the content of sector policies. With respect to the four sectors, the highest score is for agriculture (2.73), followed by forestry (2.62), water (2.55) and energy (2.33). This suggests that the combined priority approaches within the agriculture sector offer the most immediate and already planned for direct pathway to CCD, relative to the other sectors, with energy offering the relatively least viable pathway as currently viewed from sectoral policies. This finding for agriculture partly follows from the long history of conservation agriculture and climate-smart agriculture (CSA) interventions across sub-Saharan Africa (Lipper et al., 2014).

Turning to the latter, i.e. ranges of scores for each sector of the study countries, they too exhibit some variation (Table 2). Forestry shows the largest range of 1.5 (i.e. the highest being 3 and the lowest being 1.5), followed by water with a range of 1.0, agriculture with a range of 0.78 and finally energy with a range of 0.60. In the case of forestry, policies were shown to advocate approaches that both support and detract from CCD. For instance, Malawi's forestry policy advocates community-based forestry management which aligns with CCD, whilst also promoting the expansion of plantation areas that reduce the population's access to forest areas. The range of CCD scores for water is lower at 1.00, with approaches such as water use efficiency and rainwater harvesting promoting CCD, whilst large-scale infrastructure such as inter-basin transfers and large reservoirs detract from CCD, owing to the displacement of local residents for construction. Similarly with agriculture, some policies align with CCD in the form of agroforestry and approaches that reduce the level of soil carbon losses through tillage, whilst other policies promote increased mechanisation and livestock breeding programmes which can enhance carbon losses. Energy

[2] An estimated 40–55% of the SADC regional population of 277 million people are engaged in various forms of rural livelihood activities, particularly that of agriculture, and also within urban centres (SADC, 2015). Therefore the various policy approaches are considered in the context of if and how they will affect the majority of the population.

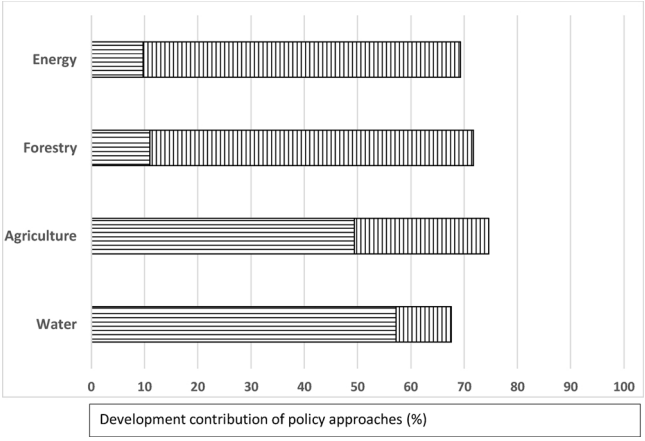

Fig. 1. Sector-wise contribution of adaptation and mitigation within the context of development for SADC countries. The length of bars along the x axis illustrates how each sector contributes to development (expressed as a percentage). The proportional contribution of adaptation and mitigation potential wins is shown by the area of each bar shaded with horizontal and vertical lines respectively.

exhibits the lowest range, with energy efficiency measures promoting CCD, but plans to increase the level of fossil fuel based electricity generation detracting from CCD.

3.2. Sector approaches and the components of CCD

For each sector, the balance of potential wins and regrets was calculated for adaptation, mitigation and development (Fig. 1, where the balance is illustrated by the length of the bar along the x axis). The net contribution of adaptation and mitigation potential wins for each sector is illustrated by the respective percentage within the area of the bar of Fig. 1. Each sector provides a different proportion of adaptation and mitigation potential benefits, indicative of the orientation of the priority approaches detailed in the sector policies.

3.2.1. Energy

Energy approaches are overwhelmingly mitigation focused (85% potential wins for mitigation and 15% wins for adaptation within the policies analysed). Policy approaches that advocate promotion and expansion of renewable energy sources (such as solar, wind, biomass, geothermal) score highly owing to their support for reducing CO_2 emissions. Similarly, approaches that promote efficiency of energy use score highly, classified as potential double wins with no regrets. However, on the whole, the SADC countries' policies in our sample prioritize both an increase in fossil fuel powered energy generation (particularly coal), as well as renewables, due to the economic development imperative of enhancing the proportion of national populations attached to on-grid electricity supplies. This leads to mitigation regrets (through an increase in CO_2 emissions) as well as development regrets (such as through increased air pollution), decreasing the mean CCD assessment score. As can be also seen in Table 3 below, while many adopted policies in all the countries can lead to potential double wins with no regrets, there is a high number that can lead to regrets. Each national political economy shapes the share of fossil fuel and renewable energy generation too. Development potential wins for energy include the expansion of energy generation within a country for industrial growth and household use, as well as increasing the efficiency of electricity use across sectors. Expansion of the electricity network will increase energy access at the household level and is considered a form of adaptation to climate change, particularly the ability to power air conditioning and fans in light of temperature rises bringing health benefits, though this is associated with negative mitigation impacts (regrets).

3.2.2. Forestry

Forestry approaches are largely mitigation orientated accounting for the majority of potential wins (84% potential wins for mitigation and 16% wins for adaptation within the policies analysed). Approaches that promote mitigation through maintaining or increasing carbon sequestration include conservation and restoration of forests and biodiversity, forest surveys and data dissemination, conservation-based research and development, gender equality and community management of forests, together with greater market access for forest products. Such approaches also promote development through strengthening rural and forest-based livelihoods, and are classified as potential double wins with no regrets. Most policy approaches in most countries fall under this category (Table 3). Adaptation potential wins are relatively less evident (16%) across the forestry sector policies, but include strategies to promote community involvement and sustainable forest management which can strengthen individual and communities' resilience and adaptive capacity. Such approaches are considered as potential triple wins with no regrets. However, only a minority of policy approaches in a handful of countries meet this goal (Table 3). Approaches that have potentially detrimental development impacts are considered to include the expansion of plantation and wood-based industries, potentially taking away land and livelihood opportunities for the majority of the local community dependent upon that resource.

3.2.3. Agriculture

Agriculture approaches offer significant potential wins for adaptation, mitigation and development. This is not surprising given the relatively longer history of the agriculture sector in seeking to harness multiple potential wins through CSA (Whitfield, 2015). CSA is defined as 'agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation), and enhances achievement of national food security and development goals (development)' (FAO, 2010, p. ii), and has seen increasing investment globally since the mid-2000s, with many CSA initiatives taking place in SADC countries (Lipper et al., 2014).

Although agriculture is primarily orientated towards adaptation (66% potential adaptation wins within the policies analysed), a significant proportion of the approaches also offer potential mitigation wins (34% potential wins within the polices analysed). Such approaches include agroforestry, agricultural extension services and CSA. They also promote development by strengthening rural livelihoods and should be considered useful in the promotion of CCD as they are classified as potential triple wins with no regrets. Agroforestry achieves both adaptation and mitigation, as it can provide assets and income from carbon, provides wood energy, improves soil fertility and enhances local weather conditions, whilst at the same time providing ecosystem services and reducing human impacts on natural forests (Mbow et al., 2014a). Other approaches that score highly with regard to adaptation and development (potential double wins with no regrets) include seed and crop storage systems, early warning systems for droughts and floods, crop diversification, improving access to markets, and enhanced agricultural research and capacity development. Interestingly, Table 3 highlights that there is great potential for almost every country's policy approaches to score triple and double wins with no regrets. Agricultural mitigation regrets include livestock breeding, increased mechanisation, and increased use of fertilisers and pesticides owing to the potentially negative impacts of over-use with associated potential development losses.

3.2.4. Water

Water sector approaches are overwhelmingly orientated towards adaptation (86% potential adaptation wins and 14% mitigation wins within the policies analysed). A variety of approaches offer numerous robust adaptation responses to changing inter and intra-annual rainfall patterns, as well as promoting development. Such policy approaches (potential double wins with no regrets) comprise the majority in almost

Table 3
Number of policies per country that achieve potential triple/double wins (no regrets) or potential triple/double wins (with regrets) with respect to the four sectors.

	Triple wins (no regrets)				Double wins (no regrets)				Triple wins (with regrets)				Double wins (with regrets)			
	A	W	E	F	A	W	E	F	A	W	E	F	A	W	E	F
Botswana	2				1	5	3	4					1	1	3	1
Lesotho					3	4	2	4		1	1		1	1	1	
Malawi	2				2	4	2	1	1	2	1		2	1	2	3
Mauritius				1	2	6	3	2	2	1	1	1	2		1	
Namibia	3					3	2	3	1	1	1		1		1	1
S. Africa	2			1	1	3	2	1	1	1	1	2		1		
Swaziland	1			1	2	3	2	2		2	2	1	1		1	
Tanzania	4			1	2	5	3			1	1	1	1	2	2	1
Zambia	2				2	4	3	3	1	1	1	1	2	2	2	
Zimbabwe	2				1	3	2	2	2	1	1	1	1	1	1	
TOTAL	18			4	16	40	23	22	8	11	10	7	12	9	14	6

Note: A = Agriculture, W = Water, E = Energy, F = Forestry.

all countries (Table 3). These include demand management (improving sectoral and/or irrigation efficiency), information and data management (improving hydrological gauging and networks) and disaster management for floods and drought preparedness planning. Operational flexibility of demand management approaches in the face of projected climate change impacts, in addition to water efficiency gains, provides potential wins for both adaptation and development. Mitigation potential wins are rarer in the water sector (14%). The most commonly mentioned mitigation win is hydropower, being a clean energy generation technique. Water approaches that advocate large scale infrastructure, such as reservoirs and inter-basin transfer, score relatively lower, owing to the displace people or their livelihood activities, considered as a potential development loss. Such approaches with negative development impacts detract from a higher mean assessment score (67%) relative to the other sectors, although this should be considered on a case-by-case basis.

4. Discussion

The southern African analysis presented here demonstrates value in cross-sectoral policy analyses as an important approach to help guide national climate change planning and assessment of the opportunities for, and remaining challenges with, mainstreaming of climate adaptation, mitigation and development into sectoral policies. Approaches scoring highly on the CCD assessment criteria have the ability to increase sectoral knowledge and capacity of both policy-makers and end-users. We identify key policy interventions that can be flexible in their construction and operation (e.g. water efficiency measures such as drip irrigation); improve overall efficiency of resource use; involve the community in their planning and management; and act as anticipatory approaches to manage climate change extremes (e.g. flood and drought management). Such no or low regret approaches can strengthen adaptive capacity, contribute to development, whilst offering some mitigation benefits (Nunan, 2017).

The first major finding that emerged from assessing the implications of how each sector aligns with the components of CCD is that agriculture provides by far the most viable pathway to CCD in accounting for both adaptation (66%) and mitigation (43%) potential wins. Consequently, government and other actors should support this core sector in order to move towards CCD. Agriculture offers the greatest number of viable approaches within a single sector (Table 3). These findings support earlier research carried out at the global level (Verchot et al., 2007) that agriculture and particularly agroforestry practices increase adaptive capacity to climate change impacts, enhance mitigation and promote development, particularly food security (Mbow et al., 2014a, 2014b).

The second major finding that emerged from the data regards the range of scores across sectors for each of the SADC countries analysed and the range of key lessons drawn from the detailed textual analysis (Supplementary material Table 2). For example, South Africa's agriculture policy (scoring 3.25) explicitly stresses the importance of CSA, along other approaches such as agroforestry that aligns directly with all three components of CCD. South Africa's water and forestry policies also score highly with 2.75 each; with the water policy advocating demand management approaches such as irrigation efficiency and rainwater harvesting; while the forestry policy explicitly supports community-based forest management and the participation of forest users in transparent decision making processes. However, South Africa's energy policy (scoring 2.60) lowers the overall mean assessment score across sectors, as it advocates fossil fuel based electricity generation along with increased generation from renewable sources. Other positive lessons can be identified from Swaziland, whose agriculture policy strongly aligns with CCD advocating agroforestry and reduced soil tillage techniques; Botswana whose water and agriculture policy aligns with CCD; and Namibia whose agriculture policy also aligns well with CCD in advocating both agroforestry and improved extension services.

At the other end of the scale, Malawi scores the lowest mean assessment score across sectors with 2.22. The Malawi agriculture policy prioritizes numerous approaches that do not align with CCD. These include increased application of fertilisers and pesticides and an expansion of livestock breeding programmes. In addition, Malawi's energy policy supports the expansion of fossil fuel based energy generation, with negative mitigation implications. Zimbabwe and Zambia also have a relatively low mean assessment score across sectors. Zambia's water policy advocates approaches such as large-scale infrastructure based inter-basin transfer (running the risk of infrastructure lock-in) and groundwater development powered by diesel generators with negative mitigation implications. Zimbabwe's water policy also advocates groundwater extraction. Both Zambia and Zimbabwe's energy policies also score relatively low, primarily owing to the policy support for expansion of fossil fuel based energy generation and incentives to develop petroleum markets and use.

4.1. Importance of findings

The findings of this study are broadly important for African countries in particular, and developing countries in general, as they press ahead with integrating climate concerns in development efforts. To begin with, while not all strategies were designed with climate change concerns in mind, undertaking a cross-sectoral comparison of key government documents has the potential to raise awareness about the potential for, and benefits from, CCD approaches. As was noted, there is substantial variability in the range of scores across sectors for each of the SADC countries. This indicates that there are examples of triple or double wins that some countries may have not recognized and capitalised upon. There is therefore great scope for countries to learn from

their regional peers and understand, appreciate and act upon the potential of policies to deliver multiple wins. In addition to learning from each other, the approach followed by this study could allow all countries to reflect upon whether there are further 'triple wins' to be harnessed, especially in the energy sector which – despite being well-positioned to do so – has been the sector facing the greatest difficulties translating CCD into action (Stringer et al., 2014).

Secondly, it allows countries in the region to explore and reflect upon whether or not there are trade-offs to be made, their nature and scale, as well as the likely distribution of the resulting benefits and losses. CCD acknowledges that the relationship between adaptation, mitigation and development is not deterministic and the three components do not necessarily operate harmoniously (D'Amato et al., 2011); they involve different time frames, communities of interest, and decision making responsibilities (Wilbanks et al., 2007). As Stringer et al. (2014) have noted, there are many possible ways in which adaptation, mitigation and development can interact. Consequently, CCD may or may not lead to 'triple wins'. Acknowledging the fact that CCD may not be appropriate for all policies and circumstances suggests therefore that there is a need for careful analysis of trade-offs.

4.2. Challenges to delivering CCD

While we consider our findings to have policy relevance, integrating climate concerns in development efforts faces a plethora of implementation challenges. A first such implementation challenge stems from their varying domestic political economy and governance arrangements (Nunan, 2017). For the energy sector, our findings corroborate previous studies in displaying the significant challenge in convincing governments to move away from a primary focus on fossil fuel based energy generation, particularly with foreign actors providing investment and construction of coal-based electricity generation in recent years (Newell and Paterson, 2010). Furthermore, the SADC region accounts for an estimated 1.6% of global CO_2 emissions (SADC, 2015), which has led governments to claim that SADC countries are entitled to power economic development by means of fossil fuels, as countries of the developed world did during the industrial revolution and subsequently (Newell and Paterson, 2010).

Similarly within the forest sector, economic pressure to increase commercialisation of forest products, often at the detriment of the local forest community and in detracting from a CCD pathway, offers an appealing means to increase income by powerful actors (Ingram et al., 2016). In the water sector, a balance of demand and supply measures offers the most viable method of managing water resources, diversifying the portfolio of management approaches at the river basin level, particularly with increasing water scarcity and competition between users (Molle, 2003). This in some cases will involve the construction of large-scale reservoirs with negative implications for CCD. However, reservoirs can be constructed and operated to minimize human displacement if environmental impact assessments are carried out in a transparent manner (WCD, 2000).

For agriculture which offers the most viable pathway to CCD, agroforestry approaches should be encouraged further through appropriate extension services (including farmers' training and capacity building) and incentive schemes developed by governments (Verchot et al., 2007) and embedded in district development plans (Dougill et al., 2017). Over-application of pesticides and fertilisers owing partly to the influence of powerful agricultural commercial lobby groups (Salami et al., 2010), in addition to livestock breeding expansion which yields substantial economic gains and provides livelihoods for rural residents (Upton, 2004), nevertheless poses challenges for CCD to be achieved across the agricultural sector in southern Africa.

A second major implementation challenge concerns the fact that government ministries and departments often operate in relative isolation of each other, characterized by a lack of communication, information sharing and collaboration (Stringer et al., 2012). To improve policy alignment and build cross-sector institutional capacity to advance CCD these challenges require urgent attention. Stringer et al. (2014) identify a number of approaches that can promote institutional support for CCD policies, practices and partnerships. These include strengthening national level coordination and clearer definition of roles across sectors; partnership development drawing on competencies of different stakeholders across sectors; steps to facilitate learning and knowledge sharing; and the development of mechanisms that permit more equitable and transparent distribution of costs and benefits. Such efforts are vital in order to harness the potential of each sector in advancing along a CCD pathway and sectoral policy analyses provide an important starting point with findings highlighting the continued need to move beyond the reproduction of the current sectoral-based political planning system.

Finally, a third challenge relates to lack of adequate resources. This challenge is exacerbated further as these countries are tasked with implementing a duo of recently-adopted global agendas (i.e. the climate and SDGs ones), while largely lacking the requisite structural, financial and technological means. Given that the sustainable development and climate change agendas are deeply intertwined, adequate support will prove pivotal in whether or not developing countries in particular will be placed on a trajectory to develop in a climate-resilient manner (Northrop et al., 2016). In other words, access to adequate resources will allow these countries to be better positioned to explore, identify and evaluate the interactions, complementary benefits and trade-offs between the SDGs and their Paris climate commitments.

As with the policy approaches analysed in this study, adaptation and mitigation actions outlined in their Nationally Determined Contributions (NDCs) can interact either positively or negatively with the attainment of the SDGs, and vice versa. For example, Malawi's NDC outlines measures to increase irrigation provision at smallholder level as an adaptation measure (Republic of Malawi, 2015). However, this could increase the incidence of malaria in nearby communities (SDG 3), owing to increased surface water in the vicinity of local populations (see also Antwi-Agyei et al., 2017). To conclude, the approach outlined in this study could be useful in assisting stakeholders in developing countries to implement their NDCs and SDGs by determining the alignment of the various policy approaches to which they subscribe with the three CCD components.

5. Conclusion

This paper demonstrates that ten southern African countries' sector polices as yet only partially align towards a climate compatible development (CCD) trajectory, with approaches that both complement and detract from CCD being prioritized by national governments. South Africa's policy approaches are the most aligned with CCD and Malawi's the least. The SDGs and the Paris Agreement offer all countries an important opportunity for (further) mainstreaming of climate planning into national sectoral policies. The water sector remains largely adaptation focused, whilst the energy and forestry sectors are more aligned with mitigation activities. Agriculture offers the greatest number of viable 'triple win with no regrets' approaches to achieve CCD across the southern African region, particularly through CSA initiatives around agroforestry and conservation agriculture. In certain instances, sector approaches with associated negative impacts on climate adaptation and/or mitigation are being advocated by study countries. These hamper development and progress towards meeting the SDGs, exacerbate climate change impacts, reduce the effectiveness of adaptation measures, and negatively affect mitigation efforts. This will detrimentally affect millions, particularly those engaged in natural resource-based livelihoods, increasing vulnerability and compounding poverty and inequality. Numerous sector policy approaches do nevertheless offer potential 'triple wins with no regrets'. National governments should focus on these to promote inclusive and sustainable economic and social development, whilst simultaneously facilitating adaptation

to the impacts of climate change and supporting mitigation activities.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.envsci.2017.10.009.

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