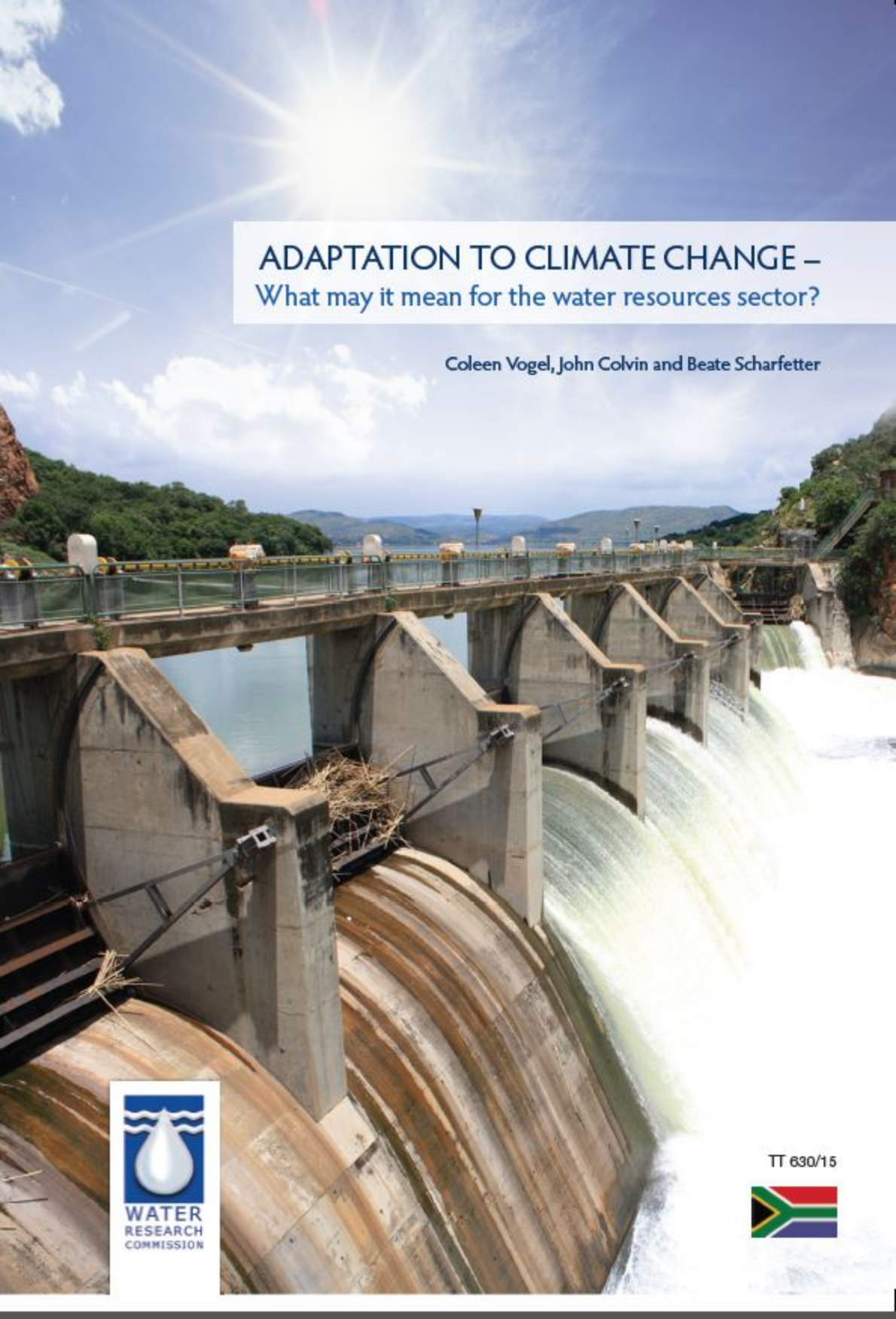

ADAPTATION TO CLIMATE CHANGE –
What may it mean for the water resources sector?

Coleen Vogel, John Colvin and Beate Scharfetter

WATER RESEARCH COMMISSION

TT 630/15

ADAPTATION TO CLIMATE CHANGE – WHAT MAY IT MEAN FOR THE WATER RESOURCES SECTOR?

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Report to the
WATER RESEARCH COMMISSION

by

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"For smarter water governance and smarter water management: context matters" (Van Zyl, 2013)[1]

Coleen Vogel[2], John Colvin[3], Beate Scharfetter[4]

INTRODUCTION

Water managers and water users are used to dealing with *change* (e.g. political change, changing economic conditions and a changing climate, land use and other challenges). Anthropogenic climate change, both in its variability from year to year and in terms of change over the longer term, is now an 'additional factor' that they have to contend with. In this short booklet, we illustrate some of the thinking and research that has been undertaken both internationally and locally to enable us to better live with climate risks in the water resources sector in South Africa.

This booklet is intended for a range of readers, but with a primary focus on those who broker innovation in the water resources sector (see Figure 1.1 for a more detailed exposition). **Our intention in this booklet is not to provide 'answers' to the wide range of issues confronting the water sector, including dealing with the challenges of climate change.** In part this is because generic answers are increasingly inappropriate, as context (be this national, local or even personal), as Van Zyl note above, becomes increasingly central to how we address issues of water governance. **Rather, we wish to stimulate personal reflection and learning as well as wider debate in the sector, by offering thinking and approaches that may add value.** Before exploring the various dimensions of climate change and the water resources sector, a brief overview of key terms and concepts is provided (Table 1.1).

Climate change: refers to "a change in the state of the *climate* that can be identified … by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer" (IPCC, 2014, 1760)[5].

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1 Van Zyl F (2013) Personal communication

2 The University of Pretoria, South Africa

3 Cinnabar (South Africa), Johannesburg, South Africa and The Open University, Milton Keynes, United Kingdom

4 The University of Pretoria, South Africa

5 IPCC (2014) *Climate Change 2014: Impacts, Adaptation, and Vulnerability, Part B: Regional Aspects*. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Maestrandrea, K.J. Mach, T.E. Baliier, M. Chatterjee, K.L. Ebie, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R.Mastrandrea, and L.L. White (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 688pp, 1760.

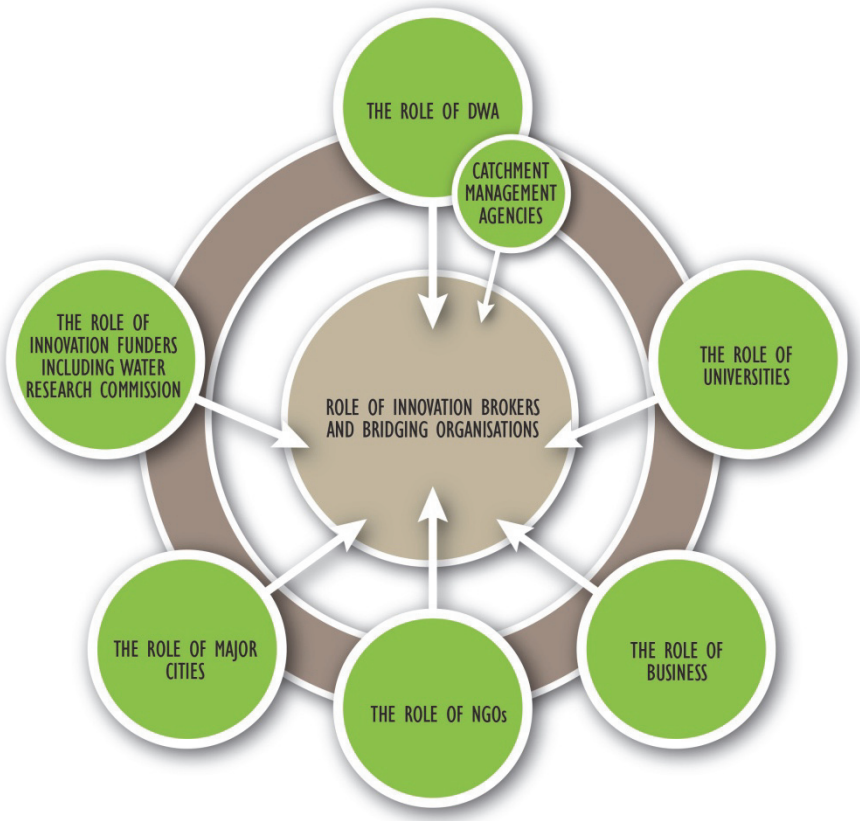

Figure.1.1 Intended audiences for the handbook, with a core focus on innovation brokers and bridging organisations.

Climate variability: refers to "variations in the mean state…. of the climate on all spatial and temporal scales beyond that of individual weather events" (IPCC, 2014, 1761)[6]. Climate is therefore made up of longer-term periods of daily changes in weather.

Table 1.1 Basic terms/concepts climate change, adaptation and mitigation. (Adapted from various sources including IPCC, 2014).

The greenhouse effect	Greenhouse gases in the atmosphere absorb and emit radiation in the climate system. Through emissions of greenhouse gases into the atmosphere humans are 'enhancing' this effect.
Climate change – adaptation	Adaptation is the "process of adjustment to actual or expected climate and its effects" (IPCC, 2014, 1758).
Climate change – mitigation	This revolves around human efforts to reduce greenhouse gas emissions and other factors 'driving' climate change (see also IPCC, 2014, 1769).

Even though the science of climate change contains uncertainties (note that we cannot even say with any certainty what is happening currently with our weather and climate), we do, however, have enough science that has been undertaken to begin to provide some ideas as to what may happen with regards to climate both, now and in the future. Such science, furthermore, enables a discussion to begin around possible actions for better management of risks and uncertainties, both now and in the future. How we use and are **informed** by

[6] IPCC (2014) op. cit., page 1761.

such science and the processes that result in the use of an expanded science, where a range of other knowledge inputs are included through science engagement, is a key focus of this booklet.

In this booklet a broad overview is provided on how climate change and climate variability may impact the water resources sector, including:

- the South African water resources context – biophysical, socio-economic and political,
- the international and national climate change context (e.g. policy framing),
- some emerging new 'framings' and ways of working with change in the water resources sector, with respect to climate change adaptation.

Some guidance is also given here, and in the WRC K5/1965 project's final report, on how adaptation to climate change in the water resources sector might be facilitated. This includes ideas on how some of the latest thinking on, and practices of, adaptation can be reflected on as South Africa progresses in its own planning in adaptation, e.g. through implementing policy and improving our practices in the water resources sector.

A brief synopsis of some of the key messages in the booklet follows:

Our socio-economic and environmental context matters:

- Climate change is an *additional challenge* that South Africa is facing that may significantly impact on development progress.
- Water, even more so than climate, is highly variable both across time and space in South Africa.

Our policy context matters:

- Vertical and horizontal challenges in the water sector add to the complexity of this sector, a situation that is made even more complex when climate change is considered.
- A central ingredient in addressing complex policy problems includes working across and between internal and external organisational boundaries and also in engaging citizens, actors and stakeholders in policy formulation and implementation.
- The National Water Act (NWA) and both the first and second National Water Resources Strategies (NWRS) are pathbreaking attempts to face head on this issue of complexity. While not using the language of complexity and associated terms, they drew on an earlier discourse of 'integrated water resources management' (IWRM) to engage with these issues.
- Critically, the NWA and NWRS can together be understood as a major reframing of the way water resources should be managed – both a major strength in policy terms and also a major challenge in terms of implementation. In contemporary policy language this reframing would be described as 'transformational'.
- Implementing an IWRM approach in South Africa has to date been met with limited success. Some researchers argue that the effective championing of an IWRM approach is likely to depend on key groups who have a stakeholding in IWRM and the South African water resources reform process. These groups include the DWA (Department of

Water Affairs, DWA – The department has gone through several political restructurings. Thus it is referred to as DWAF as an author of older publications, currently it is officially Department of Water and Sanitation (DWS). The authors in this handbook refer to only Department of Water Affairs in order to avoid confusion with regard to political organisation or responsibilities. DWA is here understood as the Department that is headed by the Minister of Water Affairs and thus the custodian of South Africa's water resources); water consultants; local as well as national and international NGOs; universities; parastatals in the water field; local, national and international IWRM networks; and national as well as international donors.

How we understand and frame the climate adaptation challenge matters:

- Different ways of 'framing' an issue matter. This is often influenced by others and a particular discourse or way of thinking.
- Ways of framing and talking about climate change can be considered historically in terms of a series of 'paradigms', focusing on: impacts; vulnerabilities and resilience; adaptation; adaptive capacity; and social-institutional learning pathways, with some significant 'turns' in the discourse between each paradigm. Within the South African research fraternity on climate change and the water sector, for example, emphasis up until 2005 was on impacts, then a focus shift was towards vulnerability and adaptation and only post-2010 has there been an emphasis on adaptive capacity and learning pathways, but with the need also identified to undertake operational catchment studies on climate change considering actual demands/supplies and storage yield. All the while, when new paradigms are ushered, work continues on the previous paradigms.
- A strong focus on vulnerabilities under climate change adaptation should reinforce the value of an IWRM approach. However, the relationships between poverty, vulnerability and the role of water in peoples' livelihoods remain poorly researched in South Africa – better understanding their dynamic inter-relationships will therefore be key to adapting current IWRM-based policies and practices in order to realise effective pro-poor water governance.
- IWRM also highlights the value of ecosystem services to catchment health/integrity and thus to a healthily functioning social ecological system. Both terrestrial and aquatic ecosystems are affected by climate change and have a key role to play both in mitigation and adaptation – for example by fixing and binding carbon in the ecosystem and by increasing resilience to impacts. 'Ecosystem-based adaptation' and the introduction of an 'ecosystem infrastructure' focus thus further reinforce the value of an IWRM approach and of the reform process set out in the NWA and NWRS.
- While adaptive management is implied by the IWRM approach, **climate change adaptation places new requirements on the priority given to adaptive management practices and the skills that underpin these. It particularly reinforces the need to move beyond current approaches to risk management and to address uncertainties, ambiguities and unknowns in new ways.** Furthermore, adaptive management strengthens the generic capacity to adapt, improving the ability to shape, create or respond to change, as well as enabling measures to strengthen absorbing capacity and reduce vulnerability.

Finding ways to build on current policies and practices, while factoring in an adaptation approach, also matter:

- The issue of how to manage for both short- and longer-term futures, i.e. both short-term shocks (or 'pulse' events) and the slower longer-term stresses (the 'push' factor), is a further defining feature of climate change adaptation and one, that to an extent, reframes the IWRM approach. In this respect, techniques such as 'backcasting from normative futures' and 'transformative scenario planning' may have much to offer. Development of normative futures (visions) is already part of the Catchment Management Strategy Planning guidelines and it might be useful to consider how these guidelines could be adapted in the context of these and related techniques.
- While IWRM principles were placed at the heart of the NWA and the NWRS, the focus on new institutions such as CMAs and WUAs and a top down, expert driven and regulatory approach to implementing the water reform process has reflected, we argue, a mechanistic way of thinking that in some ways has had the opposite effect to what was intended, i.e. closing down rather than enabling local innovation, experimentation and adaptive capacity.
- Five suggested areas for managing South Africa's water resources in a climate-changing world can be considered, based on a revised set of adaptive implementation pathways. Each of these involves a reframing of current practices and policy, enabling a move to a management style that is understood as a social and institutional learning journey, consistent with a 'paradigm 5' approach to climate change adaptation (see Fig. 3.3). These suggested areas for managing South Africa's water resources with a focus on climate challenges include:

    - **Shifting from ideal to expedient and adaptive approaches to IWRM implementation;**
    - **Shifting from top-down to self-organising approaches (while recognising that both are needed);**
    - **Enabling local self-organisation – from guidance and training to supporting learning approaches;**
    - **Designing for nationwide innovation (1): Investing in areas where autonomous adaptation/innovation is already happening ('innovation hubs'); learning from these in order to outscale if possible;**
    - **Designing for nationwide innovation (2): Investing in vulnerability hotspots learning specifically.**

In the remaining parts of this booklet we try and unpack some of these issues described above. We also hope that this booklet will stimulate discussion and enable us all to become more resilient to climate stresses.

PART 1

MANAGING WATER RESOURCES IN A COMPLEX, CHANGING CLIMATE ENVIRONMENT

Climate is highly variable in South Africa, impacting on both the availability water resources and the reliability of water services. Climate change indeed adds an 'additional layer' of change and complexity and uncertainty to an already challenging environment.

The variability in rainfall, for both current and future periods, is worth remembering. Especially as it is not only the overall trends in rainfall (i.e. rainfall increasing or decreasing over a period of several decades) and temperatures, that are important to track, but more so the seasonal, monthly and daily variability, particularly rainfall variability, and improving our understanding of the atmospheric systems and processes producing such changes.

Brief overview of climate producing atmospheric systems

The climate in South Africa varies from place to place and over time. Various atmospheric systems (e.g. cold fronts, high pressure systems and low pressure systems) interact and result in much of South Africa usually experiencing in some areas mild, warm winters in the interior and in others, cold winters with significant numbers (> 80) of days with frost. The south-western portions of the country, for example, usually experience winter rainfall and wetter conditions that accompany frontal systems that move over the country from south-west to north-east. The eastern parts of the country usually experience wetter conditions in summer in association with orographic rainfall (rainfall resulting from air being lifted over large mountains or highland areas) and the interaction between large air masses of moisture (influenced by air moving in across the Indian Ocean) and interactions with other air masses either from the north or the south of the country. A key, dramatic feature of our weather and climate is thunderstorms usually occurring in summer and another feature is that on occasion, large rain-bearing tropical systems move across the northern and eastern parts of the country.

The rain-bearing systems that provide water are thus characterized by season and vary across the country. The rainfall resulting from such systems is thus usually highly variable both across time and space. From time to time, for example, severe droughts and or periods of flooding can occur. These often, but not always, occur in association with other atmospheric phenomena, e.g. the El Niño Southern Oscillation (see discussion on some of the recent science in the Second National Communication for the UNFCCC found on DEA or SANBI web sites).

It is against this **varying climate** context (Figure 1.2) that we have to now try to understand **climate change** and prepare accordingly. Notwithstanding the debates over what is 'driving climate change' (e.g. greenhouse gas emissions, natural variability) several projections and modelling 'thought gathering' exercises are beginning to show some scenarios of what we may expect in the future, usually several decades into the future.

These changes in climate may also be accompanied by changes in extreme events (droughts and floods; SREX report)[7]. Changes that water users have to face, however, are not only generated by biophysical and environmental risks. There is a range of socio-economic and other challenges that are also present.

Figure 1.2 Simplified representation of some possible climate change projections for South Africa. Adapted from SARVA (2012)[8] and Enviroteach (2012)[9].

Examples of some of the possible, current understanding of changes and projected changes in climate are provided below (Box 1):

Box 1 Current understandings of project changes in climate

Various projections of possible changes in temperature and rainfall are contained in the most up to date, comprehensive document (DEA, 2013[10]). Examples of projections are given here, but readers are urged to read the full document:

- "All modelling approaches project warming trends until the end of this century;
- Most approaches project possibilities of drying and wetting in almost all parts of South Africa.
- Very significant warming is projected over the interior under high emission scenarios.
- A general pattern of risk, for example, drier conditions to the west and south of the country and a risk of wetter conditions over the east of the country is also projected" (adapted from DEA, 2013, 17).

More detailed climate projections by hydrological zone are contained in the LTAS first phase report (see DEA, 2013, Table A, Page 18, for examples).

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7 IPCC (2012) *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation.* A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change [Field CB, Barros V, Stocker TF, Qin D, Dokken DJ, Ebi KL, Mastrandrea MD, Mach KJ, Plattner G-K, Allen SK, Tignor M, Midgley PM (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA, 582 pp.

8 SARVA (2012) *South African Risk and Vulnerability Atlas*. www.rvatlas.org

9 Enviroteach (2012), *Let's Respond Toolkit,* page 26 (Figure 1).

10 Department of Environmental Affairs (DEA) (2013) *Long-Term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa. Climate Trends and Scenarios for South Africa*. Pretoria, South Africa

Stuart-Hill et al. (2011, x-xi)[11] provide a number of general findings, which are considered important to the adaptation debate and include (excerpts taken from WRC Project K5/1843):

• Climate change poses new challenges to water resource managers in South Africa. While not all 'gloom and doom' as some would have it, neither do results of studies suggest, as others argue, that 'everything is under control' in the water sector in regard to climate change.

• Some areas within South Africa are projected to become 'winners' with new water-related opportunities, while other areas are likely to become 'losers', or 'hotspots of concern' with more water-related stresses likely to be experienced in future.

• Projections show a general increase in the year-to-year variability of runoff into the future, often a quite substantial one, with repercussions in hydrological design and operations.

• Some components of the hydrological system such as groundwater recharge and baseflows are more sensitive to climate change than others such as stormflows, and will require special attention in management.

• There is a strong amplification and intensification when projected changes in rainfall are converted to changes in runoff responses, highlighting again the high sensitivity of South Africa's hydrological system to climate change.

Adapting and designing measures to begin to 'manage' such possible climate associated implications of change will, however, not be an easy task. As we highlight in this booklet, a range of issues need to considered including the context in which such change occurs, how actors are engaged in relevant planning and decision making processes and the implications of these new challenges for existing policy and approaches.

[11] Stuart-Hill S, Schulze R, Warburton M, Methner N, Davis N, Van Niekerk L, Ngcobo S, Knoesen D (2011) *An Evaluation of the Sensitivity of Socio-Economic Activities to Climate Change in Climatically Divergent South African Catchments.* Final report of WRC Research Project K5/1843. Pretoria: Water Research Commission.

PART 2

MANAGING WATER RESOURCES IN A COMPLEX, CHANGING SOCIO-ECONOMIC AND POLITICAL ENVIRONMENT

South Africa's water provision is not only shaped by the various atmospheric features over southern Africa such as atmospheric pressure systems including cold fronts. Water availability and use is also shaped by complex socio-economic, historical and political factors, some of which are outlined below.

Challenges of managing water resources in South Africa – history matters!

Water plays a central role in South Africa's extraordinary history. The historical context in which we in South Africa deal and have dealt with water cannot be ignored. As a result of apartheid era policies, many were deprived of land and water – the principal means of sustaining their livelihoods.

The human and physical geographies of apartheid reflect the presence or absence of water, as well as its capture and the uses to which it was put. While the alienation of competing groups of people from desirable land and water resources constitutes a primary driver of most of human history (Keegan, 1994),[12] this has been especially dramatic in South Africa, where about one-sixth of the surface area has no significant surface runoff and conversion of rainfall to usable runoff from rivers is amongst the lowest in the world (e.g. South Africa 8.6%; Australia 9.8%; Canada 66%).

A key challenge for the South African Government since the first democratic elections in 1994 therefore has been to refocus South Africa's hydraulic mission in such a way that the biophysical (including environmental) resilience of water supply is strengthened and restored and the human geographies of water-based apartheid are addressed. This is a significantly complex and difficult task, requiring not only a different way of managing water, but also an understanding of how best to transform the current system in the direction required and the ability to implement this in a water-efficient manner. It is a paradox of water resources management in South Africa that, while water plays a central role in developmental transformation, it is also by its nature complex to manage and to govern.

The complexity of managing water resources – ways of seeing the problem

Before addressing climate change one has also to understand the context in which climate change occurs. There are a number of complexities that 'shape' the water landscape in South Africa. Firstly, water must serve many priorities and these often compete with one another. The energy, mining and commercial agriculture sectors are associated with the 'first economy' and are considered priorities now as they had been in the past. Additional priorities were added after 1994 that had developed in the 1980s such as maintaining vital ecosystem services and addressing the livelihood needs of the poor and of small-scale, commercial farmers. To some extent these multiple priorities reflect the needs of multiple stakeholders, giving rise to the 'first dimension of complexity', the so-called challenge of

[12] Keegan J (1994) *A history of warfare.* New York: Vintage Books.

'**horizontal integration'** when managing water. This leads to issues that concern the need to mediate and allocate and manage water equitably, i.e. with fairness, across these various priorities.

Further complexity in the water story is also added by the challenge of so-called **'vertical integration'** – that is, the necessity that water must be managed at several scales and is not simply about managing the amount of water across society. This applies not only to the inter-connections between decisions taken at national, provincial, catchment and local scales, but even when considering a single catchment, it becomes clear that decisions concerning the whole catchment shape, and are shaped by decisions taken more locally. This is particularly evident when considering the environmental requirements of healthy catchment functioning, which operate over a whole-of-catchment scale. In particular, management of ecosystem services in the upper portion of the catchment can have a significant influence over catchment dynamics downstream (Everard *et al*., 2009a; 2009b)[13]. Yet appreciation of the value of environmental functions (Biggs *et al.,* 2008)[14] or their 'ecosystem services' (Boelee *et al.,* 2011)[15] to river health and water security often remains weak (Maloti Drakensberg Transfrontier Project, 2008; Mander *et al.,* 2010)[16].

For example, a recent study of eight rivers in the Lowveld showed that none met the environmental 'Reserve' requirement for flow, that is, non-compliance was evident throughout (Pollard *et al.,* 2011)[17]. Furthermore, with the exception of the Sabie River, this situation has deteriorated over the past decade (Pollard and du Toit, 2011a)[18]. As a result, many of South Africa's freshwater ecosystems remain in a poor state, "with 82%, 65% and 57% of estuarine, wetland and river ecosystem types respectively threatened (i.e., critically endangered, endangered or vulnerable)" (Nel et al., 2011, p.120)[19], and "with only 18% of water supply areas formally protected" (Nel et al., 2011, p.121).

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[13] Everard M, Colvin J, Appleby T, Watts B and Chimbuya S (2009a) Tools for the equitable and sustainable use of the ecosystem resources: Part 1 Modelling the private and public benefits of land use. *Environmental Law and Management*, 20, pp.70-75; Everard M, Colvin J, Appleby T, Watts W and Chimbuya S (2009b) Tools for the equitable and sustainable use of the ecosystem resources: Part 2 Internal markets for the private and public benefits of catchment use. *Environmental Law and Management*, 20, pp.76-82.

[14] Biggs H, Breen C, Palmer C. (2008) 'Engaging a Window of Opportunity: Synchronicity between a Regional River Conservation Initiative and Broader Water Law Reform in South Africa', *International Journal of Water Resources Development,* 24:3, 329 — 343.

[15] Boelee E, Chiramba T, Khaka E. (eds) (2011) *An ecosystem services approach to wáter and food security.* Nairobi: United Nations Environment Programme; Colombo: International Water Management Institute.

[16] Maloti Drakensberg Transfrontier Project 2008. Payment for Ecosystem Services: Developing an Ecosystem Services Trading Model for the Mnweni/Cathedral Peak and Eastern Cape Drakensberg Areas. Mander (Ed) INR Report IR281. [Development Bank of Southern Africa, Department of Water Affairs and Forestry, Department of Environment Affairs and Tourism, Ezemvelo KZN Wildlife]. http://www.futureworks.co.za/maloti_drakensberg_pes.htm; Mander M, Blignaut J, van Niekerk M, Cowling R, Horan M, Knoesen D, Mills A, Powell M, Schulze R (2010) Baviaanskloof-Tsitsikamma Payment for Ecosystem services: A feasibility assessment – synthesis report. [South Africa National Biodiversity Institute / Working for Water]. http://www.capeaction.org.za/index.php?C=bio&P=2001

[17] Pollard S, Mallory S, Riddel E, Sawunyama T. (2011) *Towards improving the assessment and implementation of the Reserve: Real-time assessment and implementation of the Ecological Reserve,* Final Report to Water Research Commission K8/881/2. March 2011

[18] Pollard S, du Toit D. (2011a) *Towards the sustainability of freshwater systems in South Africa: An exploration of factors that enable and constrain meeting the ecological Reserve within the context of Integrated Water Resources Management in the catchments of the lowveld,* Final Report to Water Research Commission K8/1711. March 2011, p.157.

[19] Nel J, Murray K, Maherry A, Petersen C, Roux D, Driver A, Hill L, van Deventer H, Funke N, Swartz E, Smith-Adao L. (2011) *Technical Report for the National Freshwater Ecosystem Priority Areas Project*, Pretoria: Water Research Commission

Water resources as a 'wicked issue'

The complexities we have described in the previous section are not simply technical, they are also social. Deciding how to govern and manage water at *multiple scales, across catchments (upstream/downstream), within catchments (upslope/downslope) and across diverse stakeholder needs and priorities* is socio-politically as well as technically complex. Governments usually have limited capacity to manage cross-scalar issues. Governance has therefore to broaden out to engage civil society and other relevant stakeholders, and ideally be coordinated between several inter-linked levels. We return to this critical dimension in part 4 of the booklet.

Some have described this type of governance challenge using the concept of so-called 'wicked issues' (Rittel and Webber, 1973; Verweij and Thompson, 2006)[20]. Recognition of water resources as a wicked issue is now well established in the global North (SLIM, 2004; Rubenstein *et al*., 2012)[21] and increasingly also in the global South (Biggs, 2012)[22] including in South Africa (Rogers *et al.*, 2000[23]; Pollard and du Toit, 2008[24]).

A set of scenarios, for example, has recently been constructed for the South African water sector around whether or not the decision-making paradigm (a way of seeing things) is able to come to terms with this wicked framing. One scenario axis is based on the ability to work with complexity and the other axis is based on the ability to reconcile the environmental, social and economic demands of present and future generations, i.e. sustainability (Claassen *et al.,* 2013[25]; Figure 2.1).

The policy response – Integrated Water Resources Management

Managing water effectively in a changing context requires well-thought through water policies. By examining the wider governance of water in South Africa it soon becomes clear, however, that the water 'landscape' is complex and ever changing (Figure. 2.2).

The National Water Act (RSA, 1998)[26] and following this, the first National Water Resources Strategy (DWAF, 2004)[27] were, for example, both path-breaking attempts to face head on

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[20] Rittel H, Webber M. (1973) Dilemmas in a general theory of planning, *Policy Sciences* **4** (1973), pp. 155-169; Verweij M, Thompson M (2006) *Clumsy Solutions for a Complex World Governance, Politics and Plural Perceptions (Global Issues).* Palgrave Macmillan

[21] SLIM (2004) *SLIM Framework: Social Learning as a Policy Approach for Sustainable Use of Water* (available at http://slim.open.ac.uk); Rubenstein N, Wallis P, Ison R, Godden L (2012) *Water Governance Research Initiative: Briefing Paper No. 1.* Melbourne: National Climate Change Adaptation Research Facility.

[22] Biggs (2012) Approaches and heuristics for affective polycentric water resources governance, illustrative of organizational and societal change. Introductory presentation to the special session: More systemic, more adaptive: the way forward for water governance (Ison, R, Pollard, S, Biggs, H, du Toit, D, Wallis, P, Covin, J.). First international water governance conference. Drakensberg, November, 2012.

[23] Rogers K, Biggs H, Roux D (2000) Challenges for catchment management agencies: Lessons from bureaucracies, business and resource management. *Water SA,* 26(4) 505-512.

[24] Pollard S, du Toit D. (2008) Integrated water resource management in complex systems: How the catchment management strategies seek to achieve sustainability and equity in water resources in South Africa. *Water SA* 34(6) 671-680.

[25] *Claassen M, Funke N, Nienaber S (2013) Scenarios for the South African Water Sector in 2025. Water SA 39(1) 143-149.*

[26] *Republic of South Africa (RSA) (1998) National Water Act No.36 of 1998. Pretoria: South Africa.*

[27] Department of Water Affairs and Forestry (DWAF) (2004) *National Water Resources Strategy.* DWAF, Pretoria, South Africa.

the issues of complexity and wickedness outlined above. While not using the language of complexity and wickedness, they drew on an earlier discourse of 'integrated water resources management' (IWRM) to engage with these issues.

Figure 2.1 Four scenarios for the South African Water Sector in 2025, with complexity on the X-axis and sustainability on the Y-axis. (*Source:* Claassen *et al.,* 2013[28])(Permission to reproduce obtained)

The NWA (National Water Act) and NWRS (National Water Resources Strategy) can together be understood as a major reframing of the way water resources should be managed – both a major strength in policy terms but also a major challenge in terms of implementation. For example, by seeking to integrate the three pillars of sustainability: society, the environment and the economy (Figure 2.2), the core principle of IWRM has stimulated 'transformational' thinking in the national water resources sector. Consistent with the Dublin Principles of 1992, the NWA seeks to achieve equitable and sustainable outcomes through an emphasis on decentralization of management and decision making supported by participatory processes at all levels, thus helping to balance the needs and constraints of each of the three pillars of sustainability. A remaining concern is whether the decentralized route has been or will prove successful.

[28] Claassen M, Funke N, Nienaber S (2013) Scenarios for the South African Water Sector in 2025. *Water SA* 39(1) 143-149.

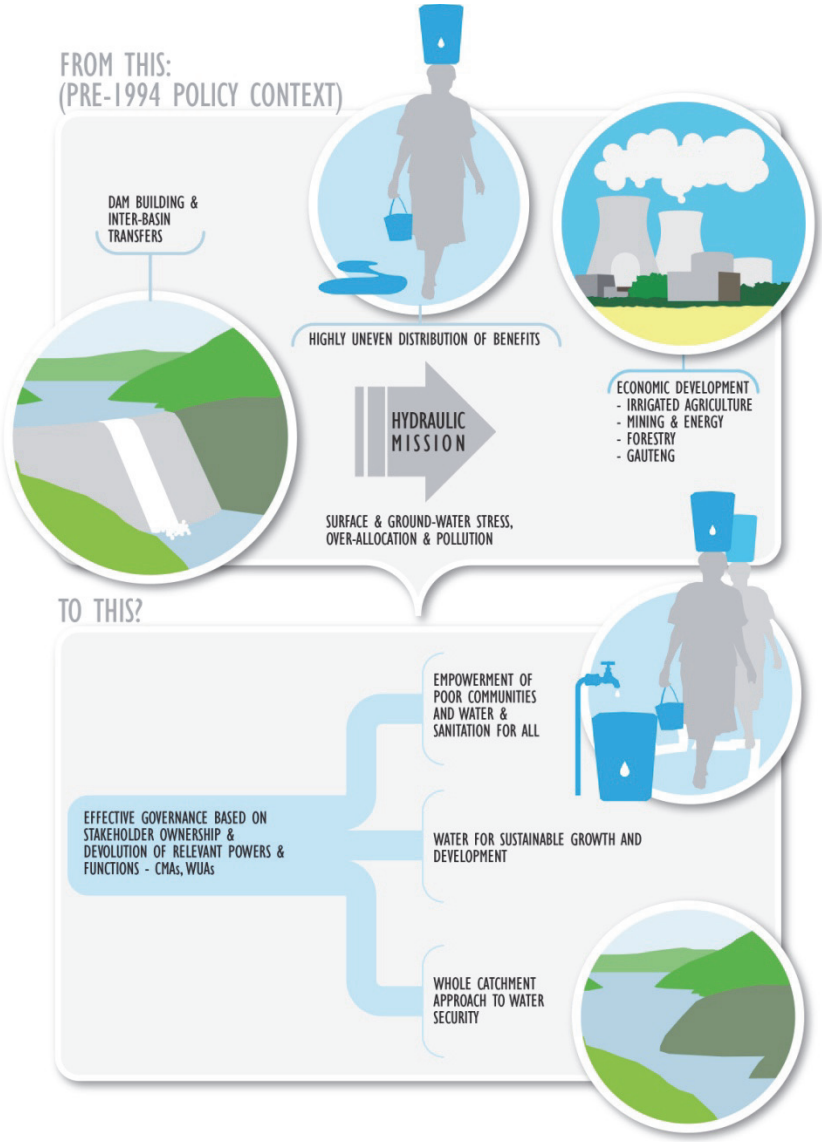

Figure 2.2 A journey of change – a reframing of policy, adapted from the NWA and NWRS.

As we show later in this booklet, we can continue to expand and build on the work of the IWRM efforts by including adaptation to climate change and climate variability into the ways we try and practise integrated water governance and management. However, in doing so it is important to remember that there are no prescribed rules shaping how this is to be done. Rather:

…..the way in which one thinks about the issues (e.g. adaption to climate change and climate variability) shapes how you approach the challenge, who you engage with (e.g. people, organizations and groups) and how you frame and shape policy and practice; and then, finally, how we all ultimately 'walk the talk'!

PART 3

AN EVER-CHANGING CLIMATE CHANGE POLICY ARENA

As much as there have been socio-economic and political changes that have influenced the water resources sector there have also been changes in the views on climate change and climate change discourse and the policy environment over time. Such changes have occurred both in the international and national context.

Climate change has been declared a major economic threat of the 21st century, with adaptation to climate change and climate variability now fully established in the scientific literature as necessary and complementary to mitigation efforts (e.g. IPCC, 2007b)[29]. Water, by being the main resource of human life and economic activity, is increasingly moving into the focus of climate change studies as well as into debates around vulnerability and resilience of our society.

While the importance of adaptation is recognised, also in South Africa (e.g. DEAT, 2010; DEA, 2011; DEA, 2013)[30], much more still needs to be done. Adaptation to climate change is not always easily understood. There are many ways of thinking about adaptation and in particular what might constitute 'successful adaptation' (Moser and Boykoff, 2013)[31].

Framings and the way one approaches an issue such as adaptation matter for our understanding, and moreover, can significantly shape what we do in practice (Leach *et al.,* 2010; see also Box 3.1)[32].

Just as the NWA and NWRS, by adapting and adopting an IWRM discourse in the South African context, sought fundamentally to change the way that water resources are managed, so too, different framings of climate change adaptation carry significantly different implications and potentials for how South Africa should manage its water resources in a climate changing world.

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[29] IPCC (2007b) Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007. [Core Writing Team, Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[30] Department of Environmental Affairs and Tourism (DEAT) (2010) *op. cit.*; Department of Environmental Affairs (DEA) (2011) *National Climate Change Response White Paper.* Pretoria: Department of Environmental Affairs; see latest trends in Department of Environmental Affairs (DEA) (2013) *Long-Term Adaptation Scenarios Flagship Research Programme (LTAS) for South Africa. Climate Change Implications for the Water Sector in South Africa.* Pretoria, South Africa.

[31] Moser S, Boykoff M. (2013) Climate change and adaptation success: The scope of the challenge. In Moser S, Boykoff M. (eds.) *Successful Adaptation to Climate Change: Linking science and policy in a rapidly changing world.* London: Routledge.

[32] Leach, M., Scoones, I. and Stirling, A. (2010) *Dynamic Sustainabilities: Technology, Environment, Social Justice.* London: Earthscan.

Box 3.1 Framing of environmental challenges

Leach *et al*. (2010) highlight that "there is a pervasive tendency – supported by professional, institutional and political pressures – for powerful actors and institutions to 'close down' around particular framings, committing to particular pathways that emphasise stability and control. In so doing, these often create universalizing and generalizing approaches. These can in turn obscure or deny the reality of alternatives. Yet addressing the full implications of the fact that we are now living in a highly dynamic and uncertain world requires **'opening up' to methods and practices that involve flexibility, diversity, adaptation, learning and reflexivity,** and an alternative politics of sustainability that highlights and supports alternative pathways." (Leach et al, 2010, pp.5-6)

In this part of the booklet, we seek to 'make sense' of adaptation by first mapping some of the changes that have occurred over time in the climate discourse (discussion and thinking) both for the international scene and for South Africa.

Ways of framing climate 'speak' are categorised into various 'paradigms' (e.g. focusing on impacts – vulnerabilities and resilience – adaptation – adaptive capacity – transformation) with significant 'turns' (or changes in the way we think) in the discourse between each paradigm (Figure 3.1).

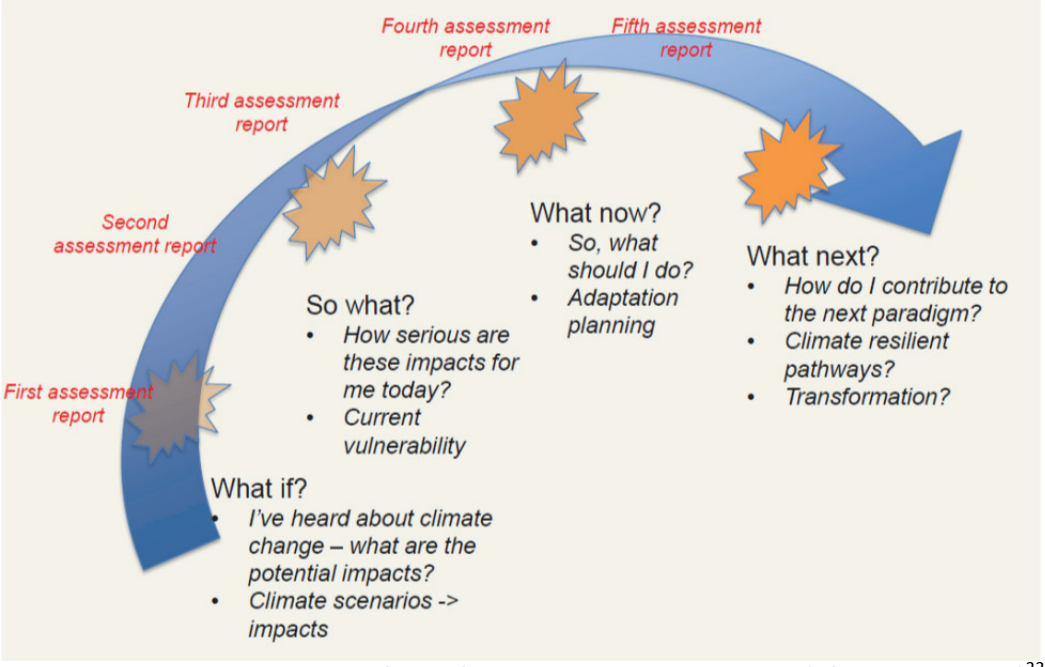

Figure 3.1 The rapidly evolving field of climate change adaptation (after GCAP, 2011)[33]

The importance of framing in the context of the evolution of climate change thinking is shown diagrammatically in Figure 3.2.

[33] Global Climate Adaptation Partnership (2011) *Adaptation Academy Module: Adaptation paradigms and prediction.* Oxford: GCAP.

The evolution of climate change adaptation practices

Changes in international thinking on adaptation to climate change have included how we think about impacts and vulnerability to climate change. Framings of adaptation as described in the IPCC assessment reports have evolved over time. Assessments of vulnerability are becoming increasingly interdisciplinary including integration of impact and adaptation assessment that includes the integration of climate change with other stresses (usually driven by complex socio-economic, political and economic concerns; Fussel and Klein, 2006, 302)[34]. This discourse in climate change can be described as being part of some major ways of thinking or what may be termed 'paradigms' (Figure 3.1), including those clustered as:

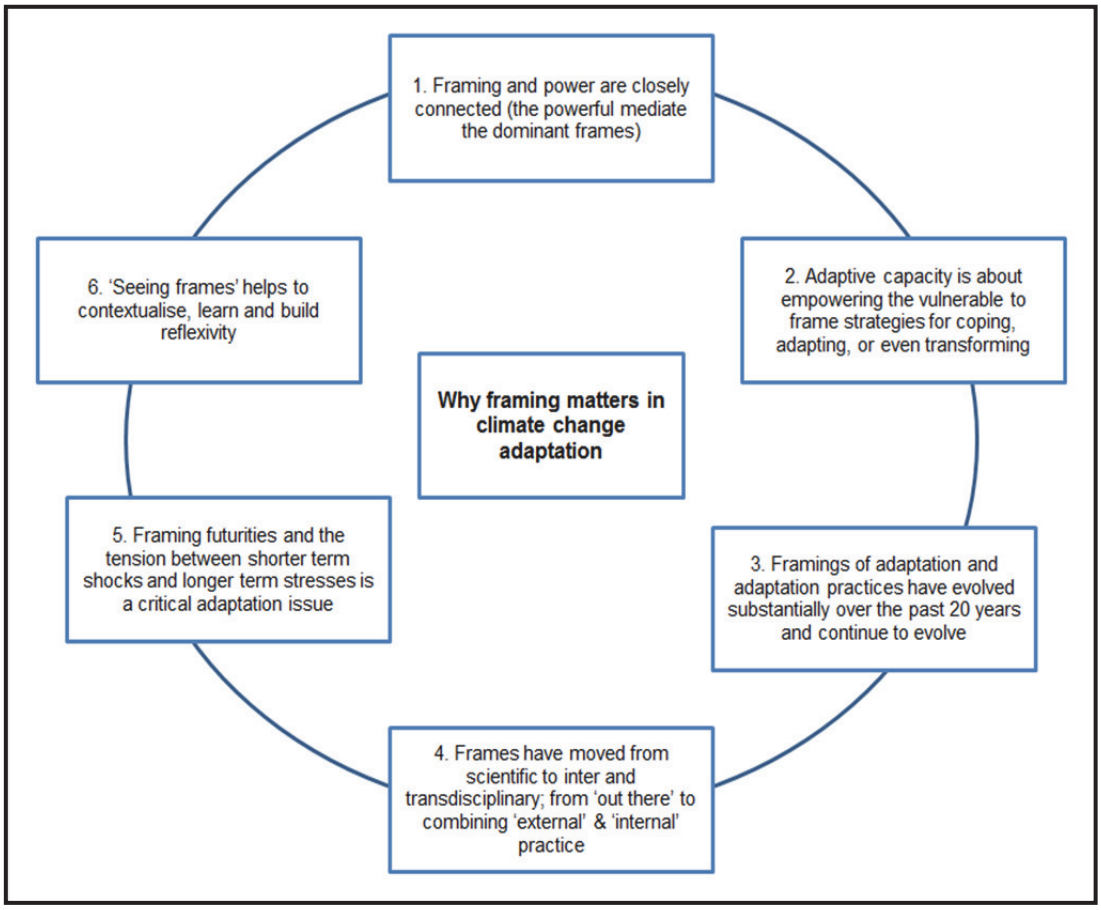

Figure 3.2 Why framing matters in climate change adaptation

- 'impacts' thinking,
- 'whole catchment thinking' including integrated assessments of feedforwards and feedbacks in an operational catchment including land use changes, community issues etc.
- 'adaptation' thinking, and more recently,
- 'transformative' thinking.

[34] Fussel H, Klein RJT (2006) Climate change vulnerability assessments: an evolution of conceptual thinking. *Climate* Change 75 :301-329

Some of the 'characteristic properties of four different stages of climate adaptation' framing are described here in more detail (Fussel and Klein, 2006, 310)[35]. The characterisation of paradigms as described in this booklet draws significantly, but not exclusively, on this work. Over time the focus internationally has shifted from a mitigation discourse in climate change to also include an adaptation focus; and from a focus that has been national to one that now also includes local to national considerations (adaptation is often heavily focused on local understanding of change). Fussel and Klein (2006)[36] also note that climate change assessments can combine features from various stages, such that each stage should therefore not be considered to follow linearly from one to the next, but rather that they may coexist, be in conflict with one another or in some cases inter-mesh. More critically, the need to include both social and physical science *and* stakeholders has grown over time. The inclusion of stakeholders and actors is fundamental to ensuring that the 'best' adaptation options are selected for the context in which one is operating. Much of this booklet focuses attention on how one can engage various actors and stakeholders, making the case that it is not only government that matters. Citizens also have a key role to play!

Neat description of linear 'paradigms' and stages as outlined by Fussel and Klein (2006) may be too organized a framing. In reality the issues in impacts and vulnerability assessments are often messy, making it very difficult to isolate 'drivers' of causality and change. A better visualization therefore may be to talk about an evolving set of framings, each associated with a pathway in which critical change points occur, leading to new framings, narratives and practices, some of which we would argue may lead to more successful adaptation, but always bearing in mind also that at any stage in the paradigms there may be the need to revisit a previous paradigm. We use the following diagram to illustrate this bifurcating landscape (Figure 3.3).

Paradigm 1 framings, or impact assessments, were mainly conducted until the early half of the 1990s and did not explicitly address adaptation. These Paradigm 1 assessments focused on *how* people or a place may respond to climate change and variations in climate. In South Africa, for example, an impact assessment may have measured what climate change may mean for a particular area but without really examining the range of factors that may either enhance or weaken the impact of climate change on a place, community or an area. Climate is seen as the main stimulator or 'driver' of change and is often seen as a biophysical 'hazard' that requires a reaction.

[35] Fussel H, Klein RJT (2006) *op. cit. (adapted from Fussel and Klein, 2006).*

[36] Fussel H, Klein RJT (2006) *op. cit.*

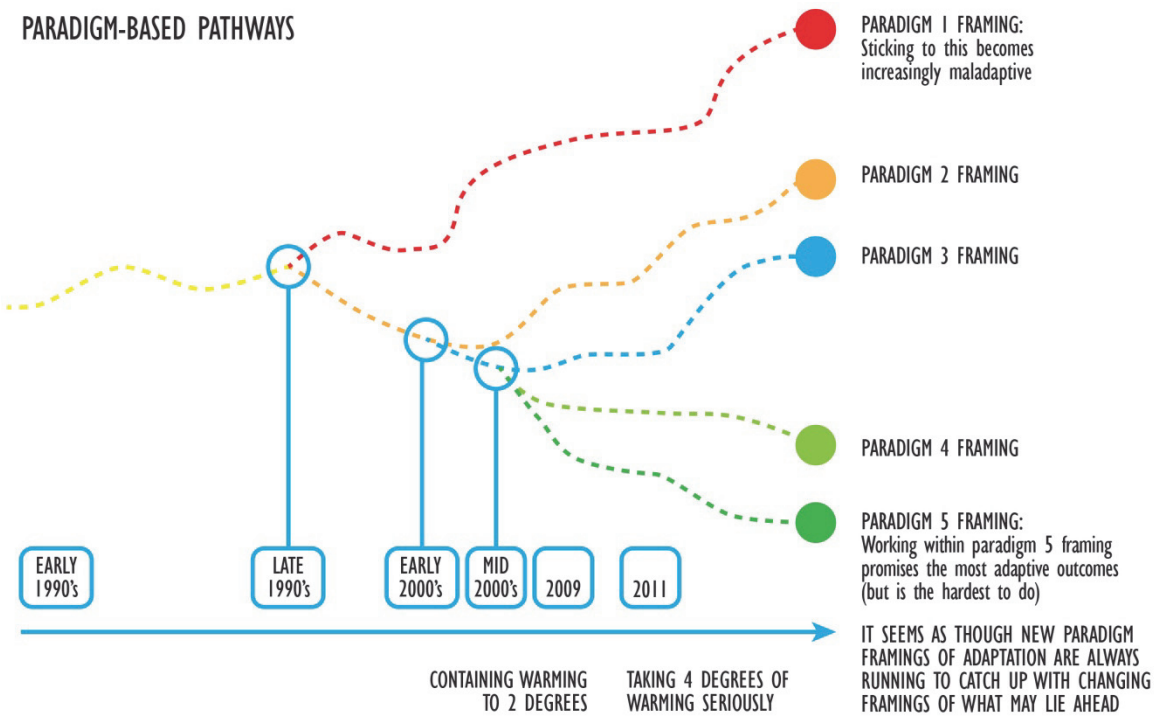

Figure 3.3 Diagram conceptualizing paradigms as bifurcating pathways as well as historical periods. *Adapted from s:* Colvin and Abidi-Habib (2012)[37] based on Downing (2012)[38]

Over time, the need to understand the *'context', moving to a more* ***Paradigm Type 2 assessment,*** in which climate change and climate variability occurs, was raised as being critical. There are few places in the world, if any, that remain pristine environments and can be described as being uninfluenced by the actions of people. Most areas have been developed, conserved or changed in some way and these areas, as well as the people who live and try and derive a livelihood from these areas, will be exposed by their actions to the influence of climate change. In the climate change language, then, the focus should not simply be on the impacts that are a result of a climate stress, but also on how vulnerable and/or robust and resilient a community or an ecosystem is in the face of changing climate. A number of more detailed vulnerability assessments thus began to be produced.

Second generation vulnerability assessments, or Paradigm 3 framings, which first appear in the early 2000s, focus on …*the capacity of people to ….implement adaptation options"* and this ability …"determines their vulnerability to climate change" (Fussel and Klein, 2006, 319). The difference of second generation assessments to earlier vulnerability assessments is a better understanding of the ability of society to respond to both current and future climate stresses.

[37] Colvin J, Abidi-Habib M (2012) *Shaping climate compatible pathways through intelligent design.* Briefing note to CDKN Asia, September 2012. Oxford: GCAP

[38] Downing T (2012) Adaptation as a Journey. Presentation to the Sussex University MSc Programme, Oxford, GCAP.

Importantly, this broadening of the framing of vulnerability also opened up a much more contested debate which asked: should the focus of adaptation be primarily on climate change, or should it be about development and how – and to what extent – climate change influences and triggers a reframing of development pathways? This debate is in turn fundamental to any discussion of 'mainstreaming' climate change and also lies at the heart of Paradigm 4 framings.

The **fourth stage** in the 'conceptual framework refers to assessments that directly address the needs of adaptation decision-makers', thus representing a fundamental shift in the assessment purpose (Fussel and Klein, 2006, 321). Fussel and Klein (2006) use the term **'adaptation policy assessment'** (Fussel and Klein, 2006, 321) when making links to policy-making, including planning and the implementation of policies. Here the notion of 'many' actors is critical to remember and that more than just a focus on 'formally' identified stakeholders and agents of change may be required.

By including this dimension of the role of policy, the question then requiring an answer is, *how* does one engage decision makers? Are there ways in which all sector stakeholders can be brought into one 'room' / 'space' when planning and deciding on our water future? For more information on how this could be possibly undertaken see the discussion later in this booklet on futures planning and the role of **transdisciplinarity**.

Finally, over the past five years, scholars and practitioners working on climate change adaptation have become interested in processes of social learning and started to talk about adaptation as a process of 'developing pathways of social and institutional learning and capacity building'. Here they borrow from a range of fields – for example in health, agriculture, water and forestry – where social learning praxes have been actively explored over the past 20 years (e.g. Ison, 2011; Colvin *et al.,* 2014)[39]. The climate change context provides a further and compelling rationale for why development in a climate-changing world should pay even greater attention to social learning approaches.

Several local and national responses to shifts in thinking around climate change and variability, mirroring in many ways the international shifts discussed above, can also be seen in South Africa (Figure 3.4).

These include:

- The development of the South African National Climate Change Response White Paper (DEA, 2011)[40];
- The Long-Term Mitigation Strategy (LTMS)[41]; and
- The Long-Term Adaptation Scenarios (LTAS) (DEA, 2013)[42].

These are briefly described below.

[39] Ison R (2010) *Systems Practice: How to Act in a Climate-Change World*, Springer, London; Colvin J, Blackmore C, Chimbuya S, Collins K, Dent M, Goss J, Ison R, Roggero PP, Seddaiu G (2014) In search of systemic innovation for sustainable development: Learning from a decade of inquiry for social learning design. *Research Policy, published online*

[40] DEA (2011) *op. cit.*

[41] Long-term Mitigation Scenarios Report, www.erc.ust.ca.za.

[42] DEA (2013) *op. cit.*

National Climate Change Response White Paper

It is interesting from a historical learning perspective to trace how South Africa's responses as a nation have emerged in regard to climate change adaptation. These activities all eventually influence how we then try and shape water interventions in the climate change 'space', particularly in the water resources sector. Examples include the UNFCCC Second National Communication (SNC)[43]; the country study report in the later 1990s compiled on a sectoral basis[44]; contributions to the IPCC third, fourth and fifth assessment reports; several scientists linked into Global Change Programmes e.g. the IGBP, International Geosphere-Biosphere Programme now merged into Future Earth (see Schulze 2007 Report on LTMS and the Global Change IBGP START Series that contained work on global and regional linkages in the Earth Systems) and the policy work of DEA in consultation with other government departments and stakeholders.

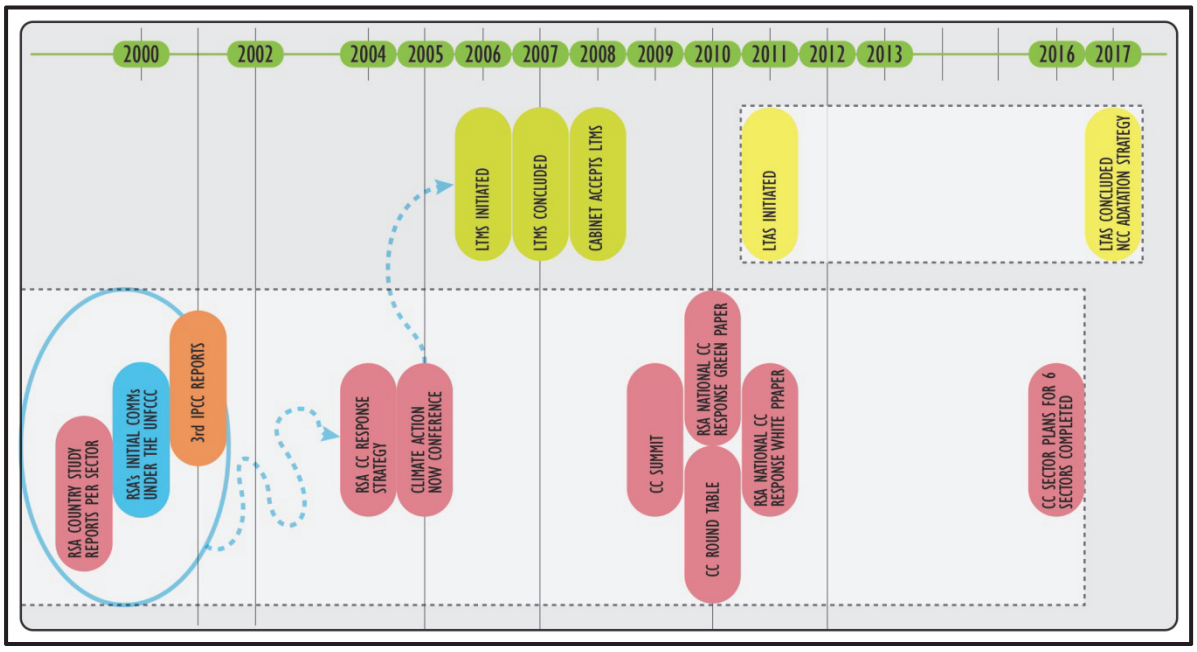

Figure 3.4 Examples of some major South African Climate Change Processes

More recent work, however, includes specific policy processes and responses. The 2004 National Climate Change Response Strategy[45] was followed by the 2010 National Climate Change Response Green Paper[46] and the 2011 National Climate Change Response White Paper (DEA, 2011).

The 2004 National Climate Change Response strategy was a first attempt by the Government of South Africa to provide national policy directives to guide the response to climate change. The development of this strategy can be considered to have been informed by the work undertaken in the drafting of South Africa's Initial National Communication

[43] DEAT (Department of Environmental Affairs and Tourism) (2010) *Second National Communication.* Pretoria: Department of Environmental Affairs and Tourism.

[44] Various sector reports were included (contact DEA for further information).

[45] DEA (2011) *op. cit.*

[46] DEA (2011b) National Climate Change Response Green Paper, Notice 1033 of 2010, Government Gazette, 25 November 2011, www.environment.gov.za.

under the United Nations Framework Convention on Climate Change and the South African Country Studies on Climate Change Reports (DEAT, 2004).

The Climate Change Response Strategy formed a platform for further discussion and debate towards the development of a dedicated Climate Change Response Policy at the 2005 "Climate Action Now" conference. The conference was attended by representatives from the private- and public sectors, academia, and civil society; creating a representative forum in which to develop key responses to potential social and economic impacts of climate change. (DEAT, 2005)[47]

Four years after the "Climate Action Now" conference, a second broad stakeholder conference was held in 2009. This Climate Change Summit initiated an intensive process towards developing a national climate change policy which included the climate change round table in 2010 during which key finding from the development process were shared with engaged stakeholders, and the publication of the National Climate Change response green paper, later in 2010.

The contents of the 2004 Strategy, the 2010 Green Paper, the 2011 policy document and the more recent 2013 NWRS[48] are all illustrative of the evolution of thinking apparent in the climate change community over this time with an equal focus given to adaptation and to mitigation. The 2009 climate change roundtable included discussions towards developing **policy responses** to not only the potential physical impacts of climate change, but also to the potential social- and economic impacts thereof on vulnerable communities.

This type of thinking can be considered to begin to be aligned with Paradigm 4 type approaches to climate adaptability. It should be noted that the shift to the 4th paradigm is a major one, in that a change in the aim of the assessment has occurred. The purpose now is to contribute realistically to the policy development process, by working with the relevant planners and policy makers on building adaptive capacity and implementing adaptation policies.

Long-Term Mitigation Strategy

In the mid-2000s a number of actions were taken by Government to begin to address carbon emissions. The White Paper on Renewable Energy, for example, set targets to be reached in a number of years. Other initiatives included the National Energy Efficiency Strategy (NEES) that establishes goals for baseline targets for each sector relative to an established baseline.

Of particular note, however, amongst these efforts was the Long-Term Mitigation Strategy (LTMS) that influenced Cabinet decisions on GHG emissions. The LTMS was initiated with a mandate from Cabinet in March 2006 and concluded with outcomes agreed by a Cabinet meeting in July 2008. At this meeting the Cabinet agreed on a strategic direction – that the country's GHG emissions must peak, at the latest by 2020-2025, stabilize for up to ten years and then decline in absolute terms. The LTMS process used a range of methods including

[47] DEA (2011c) Governance of Climate Change in South Africa (reference made to Summit and other processes informing developments of climate change policy in South Africa).

[48] DWA (2013) National Water Resource Strategy, Second Edition (NWRS2), Pretoria, Department of Water Affairs, June 2013. Department of Water Affairs, Pretoria.

energy technology optimizations etc. (See details in DEA, 2011, page 27[49]). The process, however, was also supported by strong dialogues and extensive public and private partnership engagements. The LTMS was thus able to be translated into a strategic government vision and framework for climate policy by a process of convening stakeholders from a broad range of sectors, including representatives from science, policy, and civil society. This process of shared dialogues across sectors and disciplines was considered by the participants to be an 'exceptionally important learning activity' (Ison *et al*., 2011)[50].

Long-Term Adaptation Scenarios

In a similar vein, the development of Long-Term Adaptation Scenarios (LTAS) for South Africa has also begun. In the National Climate Change Response White Paper (2011, section 8.8) the elements of an LTAS are outlined. This effort, that began in 2012, is designed around a national and regional research programme that aims to examine the cross-sectoral linkages and benefits of adaptation particularly linked to development and includes vulnerability assessments by sector (e.g. water, agriculture, urban, rural, health). Once again the process has been inclusive and has been participatory, following on the lead of the LTMS.

Notwithstanding all these efforts the burning issue remains: How does the South African water resources sector become engaged in ensuring that we are all more resilient in the face of change, including the stresses and also the opportunities that may accompany climate variability and climate change? In Part 4 of this booklet we offer some illustrative examples of how the sector might begin to think about this challenging question.

[49] DEA, 2011: National Climate Change Response White Paper, Department of Environmental Affairs, Pretoria, South Africa.

[50] Ison R, Collins K, Colvin J, Jiggins J, Roggero PP, Seddaiu G, Steyaert P, Toderi M and Zanolla C. (2011) Sustainable catchment managing in a climate changing world: New integrative modalities for connecting policy makers, scientists and other stakeholders. *Water Resources Management (Special Issue)* 25(15): pp. 3977-3992.

PART 4

CLIMATE CHANGE ADAPTATION IN THE SOUTH AFRICAN WATER RESOURCES SECTOR

Given the rich climate change adaptation landscape illustrated above, which draws on both international and national initiatives, the question then remains "What does this mean for adaptation and for preparing for climate change and climate variability **in the water resources sector and in the South African context**"?

We are all being made increasingly aware of the issue of water – both its supply and quality challenges currently and the near future. Internationally some have articulated what living in a resource constrained society may mean, including the implications both of going beyond the 'limits' of the earth's resources (Rockström *et al.,* 2009)[51] and of continuing to manage these resources in unjust ways (Raworth, 2012)[52]. It is immediately clear on reading this work that the 'safe and just resource space' needs to be managed sustainably. But what does 'sustainably' mean in a climate changing world and who defines this (Stirling, 2011)[53]? Some have begun to call for scientists to work carefully with government and others to find ways 'to steer our way across and within this space' (Leach, 2012).[54]

For South Africa these debates have significant implications and relevance, particularly in the water resources and services sector. If climate is changing and climate may, for example, become more extreme, then how are we going to **navigate our way and adapt into the future**? Drawing on our earlier work on different ways of framing adaptation, here we consider this question from the following three perspectives:

- In what ways do the challenges of climate change adaptation and appropriate responses to these, help to reinforce the value of an IWRM approach and the trajectory of the water resources reform process set out in the NWA and NWRS?
- In what ways do the challenges of climate change adaptation and appropriate responses to these, require us to extend, adapt or even reframe the IWRM approach, and how should this be undertaken?
- Who are the key actors in this adaptation process, and what roles should they be playing?

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[51] Rockström J *et al* (2009) Planetary boundaries: exploring the safe operating space for humanity, *Ecology and Society* 14(2): 32. Available at: http://www.ecologyandsociety.org/vol14/iss2/art32/;

[52] Raworth K (2012) *A safe and just space for humanity: Can we live within the doughnut?* Oxfam discussion paper. Oxford: Oxfam. ,

[53] Stirling A (2011) *From Sustainability, through Diversity to Transformation: Towards More Reflexive Governance of Vulnerability.* In Hommels A, J. Mesman J, Bijker W. eds., Vulnerability in Technological Cultures: New Directions in Research and Governance. Cambridge MA: MIT Press.

[54] Leach M (2012) *Sustainability is political. Building pathways in a safe and just space for humanity.* Expert Group Meeting on "Science and Sustainable Development Goals", UN Headquarters, March 2012.

Reinforcing the value of an IWRM approach

Implementing an IWRM approach in South Africa has to date been met with limited success. There are many reasons for this, but key issues include vested interests in the status quo, poor performance management and loss of institutional memory within the DWA, ANC patronage, and weak leadership of the reform process both nationally and locally (Schreiner, 2013)[55]. While this has led some to question the value of an IWRM approach, the DWA, to its credit, remains committed to an IWRM-based reform process and in recent years there have been several promising change initiatives at the catchment level and more locally.

There are several reasons why the need to adapt to climate change further reinforces the value of an IWRM approach. Firstly, climate change adaptation is without doubt a 'wicked' issue – some would even argue that it is 'super wicked' – further reinforcing the dynamic, uncertain and frequently contested nature of water resources management. The findings of the European research project 'Adaptation and Mitigation Strategies' (ADAM), for example, highlight that there is often no clear agreement about what exactly the adaptation problem is and there may be uncertainty and ambiguity as to how improvements might be made. This led the ADAM project to conclude that our understanding of adaptation must be framed differently, moving away from the 'predict and provide' approaches of impact modelling and decision analytical framing and towards a more inquiry-based and reflexive approach that enables stakeholders to question their underlying assumptions about what is happening and what needs to change (Hinkel *et al.,* 2010)[56].

This is consistent with the participatory and inclusive nature of the IWRM approach, highlighting the value of social learning practices underpinning multi-stakeholder engagement and dialogue (e.g. Colvin *et al.,* 2011a, b)[57]. Good IWRM practices should thus provide the cornerstone for good adaptation practices in South Africa's water resources sector.

A strong focus on vulnerabilities under climate change adaptation also reinforces the value of an IWRM approach. However, the relationships between poverty, vulnerability and the role of water in people's livelihoods remain poorly researched in South Africa – better understanding their dynamic inter-relationships will therefore be key to adapting current IWRM-based policies and practices in order to realise effective pro-poor water governance (Pollard *et al*., 2011c)[58].

IWRM also highlights the value of ecosystem services to catchment health and thus to a healthily functioning social ecological system. Ecosystems are both affected by climate change and have a key role to play both in mitigation and adaptation – for example by fixing

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55 Schreiner B. (2013) Why has the South African National Water Act been so difficult to implement? *Water Alternatives* 6(2), 239-245.

56 Hinkel A, Bisaro S, Downing T, Hofman M, Lonsdale K, McEvoy D, Tabara, D. (2010) *Learning to adapt: re-framing climate change adaptation.* In Hulme M, Neufeldt H. (2010) *Making Climate Change Work for Us: European perspectives on adaptation and mitigation strategies.* Cambridge: Cambridge University Press.

57 Colvin J, Chimbuya S and Everard M (2011a) *Learning about institutional reform by doing (1): The case of the Mvoti Water User Association.* Pretoria: Water Research Commission; Colvin J*,* Goss J, Dent M (2011b) *Synthesis report of the ICMA Watercourse and FETWater activities.* Report for project K5/2033/01. Pretoria: Water Research Commission.

58 Pollard S, Colvin J, du Toit D, Ison R, Neves D (2011c) *Building pro-poor institutions into water reform through social learning and systems approaches in order to secure water-based ecosystem services for poverty alleviation in the transboundary Crocodile basin of southern Africa.* A funding proposal to DFID. Acornhoek: AWARD.

carbon and by increasing resilience to impacts (Munang *et al*., 2013)[59]. 'Ecosystem-based adaptation' and the notion of an ecological infrastructure approach thus further reinforce the value of an IWRM approach and of the reform process set out in the NWA and NWRS.

Adapting the IWRM approach – developing adaptive capacity

While adaptive management is implied by the IWRM approach, Paradigm 3, 4 and 5 framings of climate change adaptation all highlight the importance of effective adaptive management practices and the skills that underpin these (e.g. Allen and Sankey, 2009)[60]. In particular they reinforce the need to move beyond current approaches to risk management and to address uncertainties, ambiguities and unknowns in new ways. Furthermore, adaptive management strengthens the generic capacity to adapt, improving the ability to shape, create or respond to change, as well as enabling measures to strengthen absorbing capacity and reduce specific, climate-related vulnerabilities (Ensor, 2011)[61].

However, strengthening adaptive management practices can also challenge the IWRM approach. Research from Brazil highlights tensions and tradeoffs between the different institutions and mechanisms perceived as desirable to support IWRM practices on the one hand, and adaptive management practices on the other (Engle *et al.,* 2011)[62].

Research carried out in Tanzania suggests that good adaptive management shifts the start conditions of IWRM-based reform from 'ideal' to 'expedient' approaches, focusing on the development of local adaptive capacity to solve existing or foreseen problems in pursuit of stated goals, rather attempting to impose ideal IWRM structures and mechanisms (Lankford *et al.,* 2007)[63]. Here there is a strong emphasis on participatory, social learning approaches, leading gradually over time to the introduction of IWRM principles and practices.

Adapting the IWRM approach – water reform itself as an adaptive process

While IWRM principles were placed at the heart of the NWA and the NWRS, the primary focus was on structural aspects of new institutions such as Catchment Management Agencies (CMAs) and Water User Associations (WUAs). In many cases this structural focus has led to under-investment in building capacity for full participation by various role players (Lotz-Sisitka and Burt, 2006)[64]. When this is linked with a top down, expert-driven and regulatory approach to implementing the water reform process, it is not surprising that this has had unintended consequences, in some cases closing down rather than enabling local innovation and experimentation, which studies have shown to be integral to adaptive

[59] Munang R, Thiaw I, Alverson K, Mumba M, Liu J, Rivington M (2013) The role of ecosystem services in climate change adaptation and disaster risk reduction. *Current Opinion Environmental Sustainability*, 5:47-52.

[60] Allen C, Stankey G. (2009) Synthesis of lessons. In Allen C, Stankey G eds. (2009) *Adaptive Environmental Management: A Practitioner's Guide.* Dordrecht: Springer.

[61] Ensor J (2011) *Uncertain futures: adapting development to a changing climate.* Practical Action Publishing, Rugby, 2011.

[62] Engle N, Johns O, Lemos M, Nelson D (2011) Integrated and adaptive management of water resources: tensions, legacies, and the next best thing. *Ecology and Society* 16(1) 19. URL: http://www.ecologyandsociety.org/vol16/iss1/art19/

[63] Lankford B, Merrey D, Coer J, Hepworth N. (2007) *From Integrated to Expedient: An Adaptive Framework for River Basin Management in Developing Countries,* Colombo, Sri Lanka: IWMI (International Water Management Institute).

[64] Lotz-Sisitka H, Burt J (2006) *A critical review of participatory practice in Integrated Water Resource Management.* WRC Research Report K5/1434. AWARD, Acornhoek, South Africa.

capacity (Levine *et al.,* 2011)[65].

An alternative approach might be to consider water reform itself as an adaptive process. This was the conclusion of the Tanzanian study cited above and one that is also reflected in the findings of a more recent, multi-country study by the Africa Climate Change Resilience Alliance (ACCRA). This study highlights the importance of focusing on autonomous innovation as an entry point for building adaptive capacity to climate variability and change (Levine *et al.,* 2011)[66]. This involves 'understanding how people are currently experimenting and innovating in response to different pressures, including the constraints to innovation and the uptake of new ideas' (Levine et al., 2011, p.ix). This in turn requires 'an understanding of institutional factors, power relations, and other socio-cultural factors' (Levine et al., 2011, p.ix) and the recognition that the necessary changes to development practice are often not implementable by any one organisation or individual acting alone, but rather, are systemic, thus highlighting the importance of both horizontal and vertical governance dynamics (Figure 4.1). The pioneering work on the water resources reform process in South Africa by the NGO AWARD takes just such an approach (Pollard and du Toit, 2011b)[67].

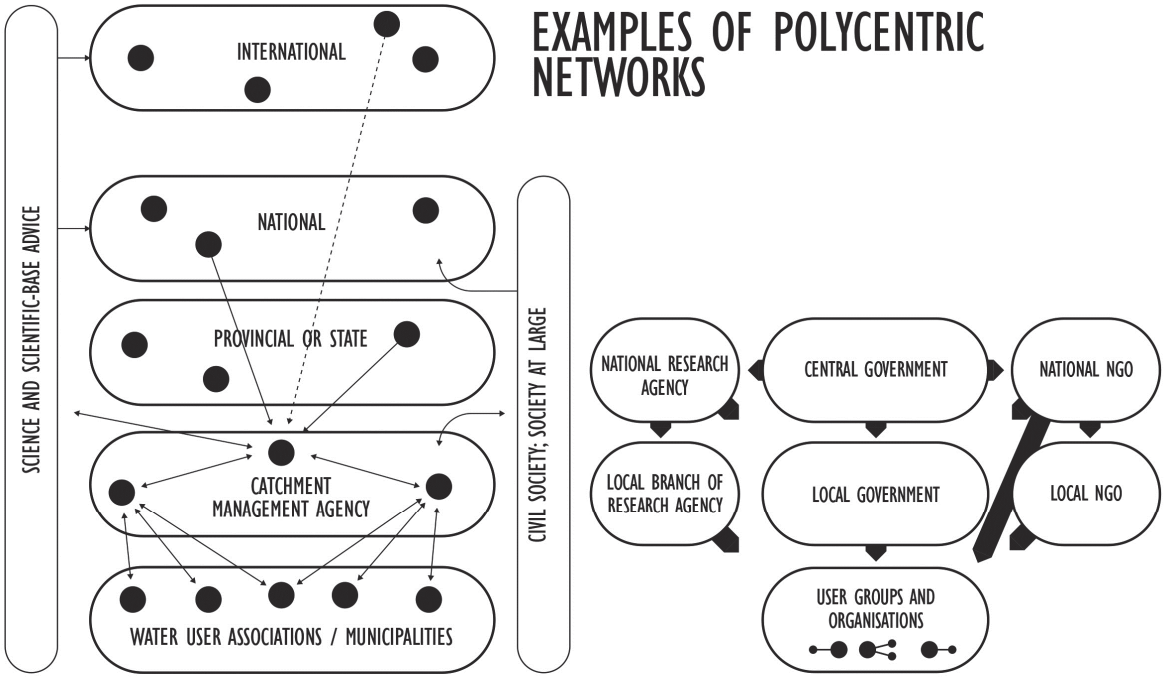

Figure 4.1 Mapping the dynamics of nested, polycentric institutional arrangements as a means to understand constraints on innovation. *Source:* Biggs (2012)[68] (Permission from author obtained)

65 Levine S, Ludi E, Jones (2011) *Rethinking support for adaptive capacity to climate change: The role of development interventions.* London: ODI.

66 Levine S, Ludi E, Jones (2011) *op. cit.*

67 Pollard S, du Toit D (2011b) Towards Adaptive Integrated Water Resources Management in Southern Africa: The Role of Self-organisation and Multi-scale Feedbacks for Learning and Responsiveness in the Letaba and Crocodile Catchments. *Water Resour Manage* (2011) **25** 4019-4035;

68 Biggs H (2012) Approaches and heuristics for effective polycentric water resources governance, illustrative of organisational and societal change. Introductory presentation to the special session: More systemic, more adaptive: the way forward for water governance? (Ison R, Pollard S, Biggs H, du Toit D, Wallis P, Colvin J). First international water governance (Ison R, Pollard S, Biggs H, du Toit D, Wallis P, Colvin J). First international water governance

Such an approach would imply a significant shift of emphasis and approach to that currently being taken to the water resources reform process. It would suggest an approach to implementing IWRM which starts with adaptation, building on people's own ability and practice of experimentation and innovation, and focusing on issues that already engage stakeholder energy and attention. In terms of the strategic design of the reform process (a key role of the DWA), it would suggest the following guiding principles:

- A shift from ideal to expedient and adaptive approaches to IWRM;
- A shift from top down to self organising approaches, while recognising that both are needed;
- Enabling local self-organisation – a shift from guidance and training to supporting a broader set of learning approaches (of which guidance and training may be a part) underpinning emergent social learning pathways.

Furthermore, a key emphasis should be on working within a dynamic, self-organising landscape to identify additional 'high leverage', 'low input' actions and initiatives that can help to 'tip' the landscape in the direction of systemic and adaptive governance as a means to achieve the outcomes and impacts set out in the National Water Act, in a climate changing world.

Adopting such an approach also suggests that there are likely to be certain parts of the country where the potential for innovation is higher than in others. These could be seen as potential **'innovation hubs'**, defined as a set of institutional arrangements where there is already some level of adaptive capacity, perhaps sitting primarily within a particular organisation, or perhaps reflecting pre-existing collaborative partnerships and multi-stakeholder networks. Some examples might include:

- *The Shared Rivers Initiative in the lowveld*, where there is a concerted effort to improve implementation of current institutional arrangements (with a focus on catchment management strategies), to apply adaptive management practices and to combine expert and participatory modelling practices (e.g. Pollard and du Toit, 2011a; 2011b)[69];
- *The payment for watershed services/second economy pathfinders in the Upper Thukela, Upper Mzimvubu and Baviaanskloof watersheds*, where there is a focus on exploring new institutional arrangements with local stakeholders, in the absence of catchment management agencies, based around the value to the local economy of managing ecosystem services under a range of climate change scenarios (Maloti Drakensberg Transfrontier Project, 2008; Mander *et al.,* 2010)[70];
- *The Berg River/Cape Town 'problemshed',* where there are multiple, interlinked stakeholder networks seeking to address intractable issues of water quality, water resources, agriculture, urban development and climate change adaptation, through

conference, Drakensberg, November 2012.

[69] Pollard S, du Toit D (2011a) *op. cit.*; Pollard S, du Toit D (2011b) *op. cit.*

[70] Maloti Drakensberg Transfrontier Project (2008) *op. cit.;* Mander M, Blignaut J, van Niekerk M, Cowling R, Horan M, Knoesen D, Mills A, Powell M, Schulze R (2010) *op. cit.*

engagement with a range of formal and informal governance systems (Callaway *et al.,* 2009[71]; Colvin, 2010[72]; Methner and Ernstson, 2011[73]);

- *Targeted rivers in the Eastern Cape,* which have served as the site of ongoing learning initiatives facilitated by Rhodes University, to build learning-based and adaptive approaches to catchment or sub-catchment management (Burt *et al.,* 2008[74]).

A focus on innovation hubs might suggest the following, additional principles to underpin the strategic design of the reform process:

- Design for nationwide innovation by investing (i) in areas where autonomous adaptation/innovation is already happening;
- Design for nationwide innovatation through (ii) targeted investment in vulnerability hotspots and by supporting hub-hotspot learning

The difference between some of the current strategic design principles underpinning the water resources reform process and an approach which emphasizes an adaptive and integrated water management paradigm, exhibits a move from command and control thinking to approaches that include devolution of power, learning, self-organisation, and broad multi-scalar stakeholder participation based on polycentric networks (Pahl-Wostl, 2007[75]).

Adapting IWRM approaches – new framings of science in support of social institutional learning pathways for adaptation

The shift to a stakeholder- and actor-led approach to innovation for adaptation, outlined above, also implies important shifts in the way that knowledge is mediated, including knowledge derived from science. There is no doubt that we will continue to need good science to support adaptive and integrated water resources management, including that which will help us to understand and manage climate uncertainty. Currently much of the evidence that is used to manage climate is informed and driven by a physical climate science (based for example on forecasts and modelling) and the need for such science will continue. Under Paradigm 4 and Paradigm 5 framings of adaptation, however, both the focus and requirements of the evidence base expand and shift to include **people and complex social-biophysical systems**, **including a focus on how resilient people and social-biophysical systems are to shocks and stresses**. People thus become and are a central part of the story and are not just a data set to be used as data reference to ensure a better projection or scenario of change. The evidence and 'science' for adaptation approaches therefore has to be drawn from a wider array of perspectives than just the 'hard' science approaches. In this view the paradigm of science can no longer just be about talking *to* society about complex

[71] Callaway J, Louw D, Hellmuth M (2009) Benefits and costs of measures for coping with water and climate change: Berg River Basin, South Africa;

[72] Colvin J (2010) *A leadership framework for climate change adaption in the context of water related planning processes.* Report for project K8/917. Pretoria: Water Research Commission.

[73] Methner N, Ernstson H (2011) The role of informal social networks in water resources governance: analyzing networks around degrading water quality and invasive "alien" vegetation in the Berg River catchment, South Africa.

[74] Burt J, McMaster A, Rowntree K, Berold R (2008) *Local institutions for water governance: A story of the development of a Water User Association and Catchment Forum in the Kat River Valley, Eastern Cape.* Water Research Commission report TT/1295/07. Pretoria: Water Research Commission.

[75] Pahl-Wostl, C. (2007) Transitions towards adaptive management of waterfacing climate and global change. *Water Resour Manage* 21, 49-62.

problems; and instead must shift to a paradigm that emerges from conversations *with* society on these issues.

One emerging arena for enabling scientists to expand the 'space' of thinking and practice in this way is that of 'transdisciplinary' science approaches, that provide a different approach to finding evidence while also engaging 'communities of action' (Box 4.1). The practice of transdisciplinary science unfolds in ways that are very different to traditional disciplinary and inter-disciplinary approaches, leading to processes that have been described as social institutional learning pathways.

Box 4.1 Transdisciplinarity

Lang *et al.* (2012, pp. 26-27) define transdisciplinarity as follows:

> 'Transdisciplinarity is a reflexive, integrative, method-driven scientific principle aiming at the solution or transition of societal problems and concurrently of related scientific problems by differentiating and integrating knowledge from various scientific and societal bodies of knowledge'.[76]

For Swilling (2012, pp. 2-3) 'transdisciplinarity has emerged as a new mode of knowledge co-production with – rather than for – society in order to deal with complex societal problems that can no longer be approached and solved by mono-disciplinary approaches only (for the most significant contributions see e.g. Hadorn and Pohl, 2008; Scholz, 2011)[77]. As a new mode of knowledge production, transdisciplinarity has been conceptualised as being capable of producing both practical, useful knowledge for solving real-world problems as well as theoretical, scientific knowledge for better understanding our complex world. Global warming and climate change; natural resource depletion; soil degradation; pollution; food security; increasing poverty; water and energy crises, are just a few examples of such complex societal problems warranting a transdisciplinary response.

These problems are complex because they are truly planetary-level problems, existing simultaneously at the global and local scales. But they are also complex because they are being produced by both nature and society, and therefore also have far-reaching long-term consequences for both nature and society. These are 'entangled' or 'hybrid' problems that can no longer be approached in terms of the two-world theory and disciplinary divide of separating the 'natural' from the 'social' as supposedly two fundamentally different and unconnected realities that can only be worked on separately by the natural and social science in isolation of society. Attempts to work within this double disciplinary and science vs. society divide can only result in the single disciplines producing partial knowledge of these hybrid problems; whereas the need today is clearly for integrated solutions based on integrated knowledge (Morin, 1999)[78].

In order to justify its claim as a new mode of knowledge co-production, capable of producing both scientific and practical knowledge, it has been critical for transdisciplinarity to establish itself within the scientific community as a credible scientific mode of knowledge production. To publicly demonstrate that the process of starting with shared real-world problem statements can be translated into scientific problem statements and research questions, which, in turn, can be worked on and transformed into scientific knowledge, the emphasis has very much been on the discovery, design and production of appropriate transdisciplinary methods that are replicable in different contexts'. [79]

A brief example from work undertaken by WWF in Colombia shows a case where the learning which underpinned the process of change for adaptation was central and

[76] Lang DJ, Wiek A, Bergmann M, Stauffacher M, Martens P, Moll P, Swilling M, Thomas CJ (2012) Transdisciplinary research in sustainability science: practice, principles, and challenges. *Sustain Sci* DOI 10.1007/s11625-011-0149-x

[77] Hadorn G, Pohl C (2008) *Handbook of Transdisciplinary Research.* Dordrecht: Springer; Scholz, R (2011) *Environmental Literacy in Science and Society: From Knowledge to Decisions.* Cambridge: Cambridge University Press.

[78] Morin E (1999) *Homeland Earth.* Cresskill, NJ: Hampton Press.

[79] Swilling M (2012) *Rethinking the Science-Policy Interface in South Africa: Experiments in Co-Production of Knowledge at Different Scales.* Paper presented at the 2012 Berlin Conference on the Human Dimensions of Global Environmental Change, Freie Universitat Berlin, 5-6 October 2012.

included reflective learning practices as the organisation began to think about how it was 'learning about adaptation' (Guevara *et al*, 2013)[80].

As the organisation moved into a phase of more reflexive, 'triple-loop' learning (Tschakert and Dietrich, 2010)[81], a number of interconnected shifts emerged simultaneously:

- shifting from a focus on working with others to develop adaptation options, to working with others to develop the skills and capacities they need, such that they might then work out for themselves what might constitute 'effective adaptation';
- learning what it means to develop those skills and capacities for themselves, in order also to help others do the same;
- becoming aware of a range of theories of change and their underpinning assumptions and framings;
- recognising that learning entails shifting from a set of linear management practices that seek to control and manage risk, to a set of adaptive management practices that involve working with uncertainty;
- accompanying this, engaging in a fundamental shift of organisational practice from seeking to control others to working with others in emergent ways and with an emphasis on learning together.

Adapting the IWRM approach – managing for both short term shocks and longer term stresses

The issue of how to manage for both short and longer term futures (short-term shocks and longer term stresses) is a further defining feature of climate change adaptation, and one that to an extent also reframes the IWRM approach. In this respect, recent planning techniques such as 'backcasting from normative futures' (ICLEI, 2013)[82] and 'transformative scenario planning' (Kahane, 2012)[83] may have much to offer. These are some of the approaches that can be sued to assist in planning in the water sector. Development of normative futures, through a process of 'visioning', is already part of the Catchment Management Strategy Planning guidelines (DWAF, 2007)[84] and it might be useful to consider how these guidelines could be adapted in the context of these and related techniques.

Who should do what? The role of different actors, with a central focus on innovation brokers and systemic intermediaries

In the previous sections we have considered how the current water resources reform process might be adapted in the context of climate change, including some strategic design principles, but in a somewhat disembodied way, without being explicit about who will do

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[80] Guevara O, Naranjo LG, Chaves ME (2013) *Past, Present and Future Dimensions of Climate Smart Conservation: Evidence and learning from WWF Colombia.* Bogota: WWF Colombia.

[81] Tschakert P, Dietrich KA (2010) Anticipatory learning for climate change adaptation and resilience. *Ecology and Society,* 15(2): 11.

[82] ICLEI (2013) *ICLEI Africa and local governments hold pioneering meeting on ecosystem approaches to urban transformation in a changing climate.* ICLEI Africa Special News Bulletin. Cape Town: ICLEI, October 2013.

[83] Kahane A (2012) *Working together to change the future: Transformative scenario planning.* San Francisco: Betrett-Koehler Publishers.

[84] Department of Water Affairs and Forestry (DWAF) (2007) *Guidelines for the Development of Catchment Management Strategies: Towards Equity, Efficiency and Sustainability in Water Resources Management.* By Pollard S, du Toit D, Reddy Y, Tlou T. DWAF, Pretoria, South Africa.

what. Yet switching, for example from top down to self-organising approaches, calls for careful thinking about who might be responsible for innovation.

In this final section of the booklet we therefore consider the actors who might be in a position to implement an adapted water reform process, noting the potential roles of a broad mix of actors from a broad mix of sectors. As previously highlighted, our primary emphasis is on actors who are capable of working with a dynamic, self-organising landscape and of identifying and facilitating additional high leverage, low input actions and initiatives that can help to tip the landscape in the direction of systemic and adaptive water resources governance.

The role of innovation brokers

In such a context, the role of those individuals who can act in what we call an 'innovation brokerage' or 'systemic intermediation' role (see Figure 1.1) is useful. We describe the qualities of this role from several perspectives including the ability to work effectively in situations of uncertainty and complexity, to broker innovation processes involving multiple actors, and to support learning and reflexivity in others (Figure 4.2). We also highlight the role of so-called 'bridging organizations', through which such individuals often operate.

These individuals are located in a variety of sectors, including NGOs, universities, business and city metropolitan government. A number of examples of individuals and/or organisations from each sector may be required for effective mobilization and upscaling of systemic intermediation practices for adaptive water reform. Furthermore, one of our intentions in this booklet is to encourage innovation brokers to further value and develop their unique role in:

R1.1 Supporting and enabling expedient and adaptive approaches to IWRM – for example through facilitation, capacity building and learning interventions;

R1.2 Supporting and amplifying self organising approaches to expedient and adaptive IWRM as these are emerging within local networks and governance systems;

R1.3 Further investing in areas where autonomous adaptation/innovation is already happening ('innovation hubs') – for example by experimenting with new approaches to managing for futures at different timescales, and/or by deepening adaptive management and governance practices.

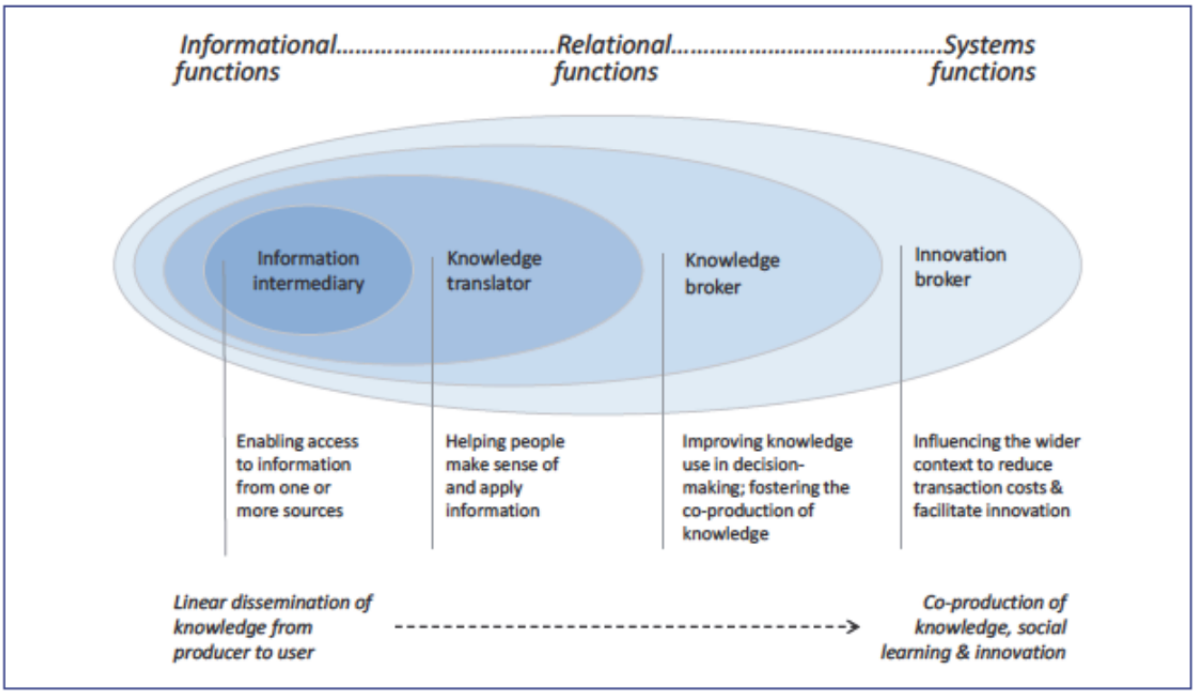

Figure 4.2 Diagram showing the role of innovation brokers at one end of a continuum of knowledge intermediation functions. *Source:* Shaxson *et al.* (2012)[85] (Permission obtained to reproduce)

The role of the DWA

In a more distributed, self-organising innovation system for climate adaptation, what role should the DWA adopt in the water resources reform process? By viewing the water reform process through a more dynamic, emergent and self-organising lens, which could include stronger collaboration and mutual learning between existing systemic intermediaries, some new opportunities are also opened up for the DWA to play a significant leadership role. Key elements could include:

R2.1 Possible inclusion, where relevant, of systemic intermediaries in both innovation hubs and vulnerability hotspots;

R2.2 Considering a significant investment in a vulnerability hotspot, supported by networks with one or two innovation hubs;

R2.3 In expediting the development of Catchment Management Agencies, encouraging these agencies to work closely with local systemic intermediaries;

R2.4 Supporting an emergent strategy for adaptive and integrated water governance, for example by fostering learning networks within and between CMAs;

R2.5 Demonstrating strong leadership at a national level within the water – food – energy – climate security nexus.

[85] Shaxson L with Bielak A, *et al.* (2012) *Expanding our understanding of K*(KT, KE, KTT, KMb, KB, KM, etc.) A concept paper emerging from the K* conference held in Hamilton, Ontario, Canada, April 2012.* Hamilton, ON: UNU-INWEH.

The role of the Water Research Commission (and other funding agencies)

We hope also that this booklet will encourage the WRC to reflect on areas where it can exert maximum leverage within a more dynamic, emergent and self-organising landscape of water resources reform. Value added contributions could include:

R3.1 Investing in further research to map and highlight the work already being undertaken by systemic intermediaries;

R3.2 Investing in action and transdisciplinary research approaches that can contribute to the transformational reform approach outlined in this booklet;

R3.3 Working with the DWA and with systemic intermediaries to develop an approach to monitoring and evaluation of the ongoing water resource reform process, based on an appropriate theory of change and relevant monitoring, evaluation and learning tools such as developmental evaluation (Patton, 2010)[86].

[86] Patton MQ (2010) *Developmental Evaluation: Applying Complexity Concepts to Enhance Innovation and Use.* New York: The Guilford Press.

CONCLUSIONS

A key theme underpinning adaptation to climate change and climate variability presented in this booklet has been to highlight the need to include approaches that enable more **open, participatory and flexible processes based around learning approaches that focus on the context of where change is occurring**. As we argue in this booklet, the context in which change occurs orientates how you begin to understand, 'frame', 'shape policy and action' and how you 'implement changes and actions'.

A further key message in this booklet has been is that **no one group or person has all the answers or 'framings' needed for such a complex challenge such as climate change adaptation**. Climate change science, for example, in projecting and understanding the climate system, must continue *but* linked to such work is also the need to include a more rigorous social and transdisciplinary science effort that can help us better understand and work in real time with the ways in which power and relations of power between and within societies frame the contexts in which climate change and climate variability occurs. To achieve such an approach, we argue, a range of actors must be engaged and involved.

A central emphasis has also been that **there is no single recipe for success**. It is no longer appropriate to think in terms of a 'tool kit' or menu of options that can be used. Rather, there is a need for every actor in the water resources reform process (and beyond) to be thinking more reflexively about what climate change means, including at a personal as well as a professional level. O'Brien (2013)[87], for example, argues for the value of adaptation from the 'inside-out' as a complementary approach to thinking about and doing adaptation in the world, highlighting the value of reflecting on the perspectives we bring to adaptation research and practice, including our own blind spots in and to change.

In this booklet we have tried to show how some particular approaches can be reflected on and used in the water resources sector, building on the strong legacy we already have in the sector. This work has also been inspired by the Water Research Commission project K/1965, that both funded the development of this booklet, while also providing us with a live case study. In this project we thus used the case as an experiment to trial several of the approaches discussed here, and enabling us to see first-hand what generated successes, what processes created limitations and more critically, what key lessons were learnt when trying to enable climate change adaptation practice.

In terms of the key scientific findings stemming from the research, we conclude with the following:

- **Adaptation requires listening and learning and not just policy change. To get it right we need to create the 'spaces' where a shared understandings of climate change and climate risks can be discussed and questioned.**
- **A transition of research praxis toward transdisciplinary research will imply significant consequences for current institutional architectures within several systems.**

[87] O'Brien K (2013) The Courage to Change: Adaptation from the Inside-Out. In: Moser C, Boykoff M (eds.) *Successful Adaptation to Climate Change: Linking Science and Policy in a Rapidly Changing World.* Routledge: Abingdon.

- **Transdisciplinary and social learning approaches require new research methods, a suitable training of junior scientists, and specific career pathways beyond disciplinary boundaries – to name only some aspects of science system capacity building.**
- **Transdisciplinary and social learning approaches require new management approaches, a suitable training of junior AND senior staff, and specific career pathways beyond job profile descriptions – to name only some aspects of capacity building in the water sector.**
- **Finally, history matters – one cannot forget the processes, efforts and championing work of those people and policies that have gone before us and that shape our unique South African context.**

A key question that then arises from this is: Do we – individually and collectively – have the courage to continue a journey of transformation in the water resources sector to enable effective adaptation to change, including to climate change?