Working paper

Climate Risk Management Tools for the Water, Sanitation and Hygiene Sector

An Assessment of Current Practice

Julian Doczi [1]

Abstract

This study aims to review and reflect on the existing 'tools' for adapting to, and managing the risk of, climate variability and change on water supply, sanitation and hygiene (WASH) services, within the wider water sector context. Using a strict screening definition for 'tools' specific to this context, the study nevertheless identified 137 unique and relevant tools, some of which overlapped significantly. The study also concluded that these tools are largely a 'supply-driven' industry, with little evidence of user 'demand' for many of them. This study does not generate any tools itself, but offers advice to influence whether and how new tools are created, and how both new and existing climate risk tools could be made more efficient and effective for WASH services. It concludes with some brief and very practical guidance for both tool users and tool developers.

[1] Research Officer, Water Policy Programme, ODI. Email: j.doczi@odi.org.uk

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All errors or omissions are my own. I likewise welcome any and all feedback on the content of this work.

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Abbreviations

ADB	Asian Development Bank
ALM	Adaptation Learning Mechanism
APWF	Asia-Pacific Water Forum
CCCCC	Caribbean Community Climate Change Centre
CCORAL	Caribbean Climate Online Risk and Adaptation Tool
CRiSTAL	Community-Based Risk Screening Tool – Adaptation and Livelihoods
CRM	Climate Risk Management
DFID	UK Department for International Development
ENSO	El Niño-Southern Oscillation
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GWP	Global Water Partnership
IDS	Institute of Development Studies
IISD	International Institute for Sustainable Development
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated Water Resources Management
M&E	Monitoring and Evaluation
MDG	Millennium Development Goals
NAO	North Atlantic Oscillation
OECD	Organisation for Economic Co-operation and Development
RCAA	Rapid Climate Change Adaptation Assessment
SEI	Stockholm Environment Institute
UNDP	UN Development Programme
UNEP	UN Environment Programme
UNFCCC	UN Framework Convention on Climate Change
USAID	US Agency for International Development
VIP	Ventilated Improved Pit Latrine
WASH	Water (Supply), Sanitation and Hygiene
WEAP	Water Evaluation and Planning System
WHO	World Health Organisation
WRM	Water Resources Management
WSP	Water Safety Plan
WWF	World Wide Fund for Nature
WWMWQ	Wastewater Management and Water Quality

Executive Summary

The impacts of climate variability and change are being felt on every sector, but few more acutely than the water sector, especially in the developing world. Globally, huge numbers of people still lack adequate access to water, sanitation and hygiene (WASH) services, and this poor state of affairs contributes to making the sector particularly vulnerable to both this existing climate variability and to future climate change impacts. In response, the development community has begun creating a wide variety of so-called 'tools' for various stakeholders from various sectors (including WASH) to use, generally with the purpose of promoting some aspect of adaptation to, or risk management of, this climate variability and change. From a development practitioner's perspective, the discourse around the use of these so-called 'climate risk management tools' for this purpose has expanded rapidly, with many hundreds of tools having already been created and many previous reviews of these tools already undertaken for other sectors. That said, most of these previous reviews to date have either focused on analysing only small numbers of the most popular tools, or have focused on broadly collecting tools without any analysis at all. This study attempts to bridge this gap, by undertaking a broad review of these climate risk management tools and also including analysis that reflects on the state of this 'tool industry' to date, offering practical advice and insights to people interested in using or developing tools themselves. It also does this with a new and explicit focus on tools relevant to WASH services, though its lessons and recommendations are applicable for these types of tools in any sector.

The study undertakes four main activities. It first creates an analytical framework for assessing these 'tools', by creating a definition of a 'tool' and a categorisation system for them. The study defines 'climate risk management tools for WASH' in this context as, '*documents, computer programmes or websites that clearly and thoroughly operationalise a set of principles or practices that could build the resilience of WASH services to current climate variability or future climate impacts, preferably in an engaging and user-friendly manner*', then categorises them based on their function and sector. This clear operational screening criteria allows the study to maintain a realistic scope, excluding all those potential 'tools' that do not explicitly describe their methods in a way that could be easily replicated by users. This process is described in Chapter 2.

Secondly, the study then uses this definition and classification framework to screen a broad array of existing resource material on climate and WASH for potential inclusion as 'tools' in this context. It first describes 11 of the main tool reviews of this nature that have previously been undertaken, then screens their reviewed 'tools' for inclusion here – some of which were excluded due to these previous reviews defining a 'tool' in different ways. It then ventures beyond these reviews, using standard literature search techniques to identify and screen additional candidate tools. Overall, this exercise describes 137 unique 'climate risk management tools for WASH', 46 of which had not been previously reviewed, though the study screened and rejected several hundred more candidate 'tools' that did not meet the strict screening definition used here. This process is described in Chapter 3 and the full list of the 137 tools is laid out in the Annex.

Thirdly, the study then reflects on these results, drawing lessons learned from the developments in this tool industry to date. It first considers whether this overall number of 137 tools is too few, too many, or an adequate number to meet the needs of most functions and users without significant overlap. Its conclusion on this is that there are indeed significant degrees of overlap between some of the more general climate risk management tools, due both to their desire for cross-contextual versatility and to their inherent limitations on climatic specificity, arising from the continued uncertainty in local climate impact projections for many parts of the world. It then considers whether there is evidence for strong latent user demand for these tools, or whether the industry is predominantly 'supply-driven'. Although the majority of available evidence on this question was proxy in nature (e.g. social media hits of the tools), most of it did not suggest any evidence of strong user demand, nor did the lack of successful tools developed by the private sector, which would have indicated demand through user willingness to pay. With these reflections in mind, the study then discusses some of the design aspects that affect the success of these tools. It highlights some 'ideal' qualities of good tools, but emphasises the difficult trade-offs involved in achieving some of these qualities at the expense of others, with no single tool ever able to be 'perfect' for all users. These reflections are described in Chapter 4.

Fourthly, and finally, the study then gathers these reflections and synthesises them into very brief and very practical pieces of advice for anyone interested in using or developing tools. If you only have time to read one chapter of this study, we recommend that you read this one, as it summarises the key learning from the rest of the study into two brief and focused pages of recommendations. The first page gives advice for those interested in using tools, while the second page gives advice for those interested in developing tools. The recommendations should also be interesting for other stakeholders that may read this, such as donor staff and academics. These recommendations are described in Chapter 5.

1 Introduction

This chapter aims to provide an introduction to this piece. It first overviews the broader climate change and water sector context, then discusses the rationale for this study and its scope and methodology. It concludes by outlining the content of the rest of the study.

1.1 The Climate and WASH Context

To begin, it is necessary to highlight the continued lack of progress to date in many countries towards universal and sustainable access to water and sanitation.[2] Access to water supply and sanitation was included as a target within the UN Millennium Development Goals (MDGs), but, as the 2015 deadline on these goals approaches, progress has been slow, particularly for sanitation. Although the MDG target for the provision of 'improved' water supply has been achieved,[3] more than 768 million people worldwide still lack access to this essential service (WHO and UNICEF, 2013). Likewise, 2.5 billion people still lack access to the similarly essential service of improved sanitation[4] – with over 1 billion of these still practicing open defecation. It is extremely unlikely that the MDG target for sanitation will be met by 2015.

The importance of improving this situation is undeniable, and a wide variety of authors have reported on the economic benefits gained from investing in WASH. The most recent estimate by Hutton (2012) puts the global benefit-to-cost ratio on sanitation spending at US$5.50:1 and the ratio on drinking water spending at $2.00:1. He also estimates the total global economic losses associated with inadequate WASH to be $260 billion annually, or 1.5% of total GDP of the 136 countries included in the analysis. Most of the potential benefits of improving this situation (about 70%) come in the form of the economic value of time savings, for both water and sanitation interventions. South Asia, East Asia, and sub-Saharan Africa stand to benefit the most from investment toward meeting these MDG targets, according to the study.

On top of these existing problems comes climate change. As reported by the Intergovernmental Panel on Climate Change (IPCC) in its *Fourth Assessment Report* (AR4), the steady rise of global greenhouse gas (GHG) emissions has been relentless, and with an international agreement on climate change mitigation still elusive, this trend will

[2] The problem is not simply one of access to services either. The broader 'water sector' is also plagued by serious challenges on water resources management (WRM) and on wastewater management and water quality (WWMWQ). These were largely ignored in the original MDG process, but have been included to a greater extent in the post-2015 development process to date.

[3] The MDG process defined 'improved' drinking-water as: piped water on premises, public taps / standpipes, tube wells / boreholes, protected dug wells, protected springs, and rainwater collection.

[4] 'Improved' sanitation was similarly defined as: flush / pour-flush toilets to a piped sewer system, septic tank, or pit latrine; ventilated improved pit latrines (VIPs); pit latrines with a slab; and composting toilets. Facilities that are shared between two or more households are excluded and are deemed 'unimproved'.

almost certainly continue (IPCC, 2007; UN, 2013). The importance of preparing to adapt to the predicted impacts of climate change – by investing in projects to decrease vulnerability and increase resilience – is thus similarly undeniable. This is especially true for developing countries, whose low levels of adaptive capacity make them more vulnerable and less resilient to the climate impacts that will affect them (Adger et al., 2003; Sperling, 2003; Stern, 2007, Ch. 3 and 4).

The impacts of climate change will be felt on every sector, but few more acutely than the water sector. Two key studies on these impacts are the IPCC's *Climate Change and Water* technical report (Bates et al., 2008) and the *Vision 2030* report by the WHO and the UK Department for International Development (DFID) (Howard and Bartram, 2009). Both reports, as well as a thematic review by Calow et al. (2011), detail potential climate impacts on WASH, with some of these key impacts described in Box 1.

Box 1: Summary of predicted climate change impacts on WASH

- Increasing atmospheric temperatures, reducing water supply availability in meltwater-fed basins
- Increasing surface water temperatures, reducing water's dissolved oxygen content, mixing patterns and self-purification capacity, while increasing algal blooms
- Sea-level rise, salinising coastal aquifers and threatening coastal WASH infrastructure
- Shifting precipitation patterns, changing local surface water and groundwater availability, flow and recharge patterns
- Increasing precipitation variability, increasing the difficulty of stormwater management, flood control and reservoir use
- Increasing evapotranspiration, reducing and salinising local surface water and groundwater
- Changing frequency and intensity of extreme events, damaging WASH infrastructure and introducing their pollutants to the local water resources and affecting water quality, availability and fluvial erosion

Not every projected impact will happen everywhere. Likewise, these climate impacts will put a premium on better local information about water resources, yet few countries have strong existing data sets on this. The risks of impacts on water availability or flow regime are rarely a simple physical problem either, with issues of access, entitlements and equity often playing a significant role in water management decision making. Similarly, these climate impacts are but one of a number of growing and similarly non-stationary pressures on WASH and livelihoods, with others including demographic shifts, urbanisation, changing consumption patterns and pollution. Climate change is simply the newest of these and the one we appear to have difficulty in integrating with the others.

Source: Bates et al. (2008, p. 70); Howard and Bartram (2009); Calow et al. (2011)

The report by Bates et al. (2008) discusses how climate change will impact on both the average and extreme temperatures around the world and the frequency, location, and intensity of precipitation events. This has enormous implications, with more extreme precipitation events in some areas increasing the frequency of floods, while reduced precipitation, elevated evapotranspiration and greater numbers of hot days in other areas will increase the demand for water and the subsequent risk of droughts. Shifts in the timing and seasonality of precipitation are also already widespread, with growing evidence as well for significant shifts in the intensity and severity of tropical cyclones and in the global 'climate engines', such as the El Niño-Southern Oscillation (ENSO) and the North Atlantic Oscillation (NAO), amongst others. In monsoon climates, which include many of the

developing world's most vulnerable nations, all of the above may occur in the same region. For example, in the Caribbean, rainy seasons are projected to be shorter, but with greater intensity of heavy rains (potentially resulting in floods), while dry seasons could be longer and with decreased precipitation overall (potentially resulting in droughts). Both of these extremes pose serious threats to the water sector, by affecting water quality and quantity, which subsequently impact on the operation of WASH infrastructure and delivery of services.

In addition to increases in climate variability, shifts in 'mean' climate conditions are occurring as well, with the emergence of novel climate states. These new states will become increasingly widespread and present significant challenges for the development and reliable operation of long-lived water infrastructure (Matthews et al., 2011; Brown, 2010). Given the significant investments these represent in many developing countries, maintaining existing WASH services will prove very challenging even without any additional demographic, economic and environmental pressures.

The *Vision 2030* report by Howard and Bartram (2009) then took a more technology-focused approach. It assessed the vulnerabilities of current WASH technologies under three different rainfall scenarios and made recommendations on ways to 'climate-proof' them in the future, so as to avoid backsliding on the MDG targets. It also emphasised that there is sufficient climate knowledge now to warrant significant and urgent changes to policy and planning around current and future WASH investments, with many WASH interventions having high levels of theoretical resilience to climate impacts, if only *properly managed* with these impacts in mind.

While the weight of available data indicates that many aspects of policy and planning do indeed need to change, understanding how to operationalise this for many developing countries at local-level – and even country-level – is not at all straightforward. The reasons are both scientific and institutional. Institutionally, the awareness by decision makers of climate change is still new enough that many of the issues cut across organisational and ministerial boundaries and provoke novel coordination and interoperability concerns, such as between energy, water, health and environment ministries (Sachs, 2008). Moreover, the technical outputs of water- and climate-relevant sciences have remained inadequate to provide explicit guidance to decision makers.

The scientific gaps derive from the large uncertainties of climate impacts and our inability to attain sufficient quantitative certainty about the nature and rate of additional changes. As Bouwer et al. (2013) highlight, this is due to the low confidence of even the most advanced global climate models, which decreases even further at the spatial and temporal scales at which water is typically managed. They point out that these models were not developed to guide climate adaptation decision making and often frame impacts and uncertainties in ways that make their application to decision making problematic. While the imminent IPCC Fifth Assessment Report represents a new generation of models and outputs, early indications are that their essential limits have not substantially changed. We cannot expect climate models to provide effective guidance for precise water management guidelines, which is a critical point to keep in mind for the later sections of this paper that discuss and compare climate risk management tools, as it necessarily simplifies their available guidance and methods. New so-called 'bottom-up' or 'model-neutral' methodologies are being developed that can avoid many of these limitations (Weaver et al., 2012). Clearly, however, existing 'stationary' approaches seem certain to prompt decisions that will restrict and limit adaptive capacity for the future, with the potential for reducing our ultimate efficacy in WASH.

That said, uncertainty does not necessarily prevent early action. As Calow et al. (2011), Batchelor et al. (2010) and the Global Water Partnership (GWP, 2007) argue, the many existing problems facing WASH services are the primary drivers behind much of its existing vulnerability to climate impacts. This is especially since many existing WASH services (or lack thereof) cannot yet even cope with existing climate variability, never mind

future impacts. By effectively addressing these existing problems, the sector would already be well on its way to building better climate resilience. Focused adaptation to future climate impacts is still needed though, even if climate impact projections are uncertain. A focus solely on resilience to current climate variability would overlook issues such as the need for transformation in sectoral decision-making, in light of the new risks and opportunities presented by this systemic climate change (e.g. Brown (2011)).

1.2 Rationale for the Study

How then can WASH services adapt to – and manage the risk of – climate change? There are a wide variety of possible approaches that relevant stakeholders can take, from simple infrastructure or behaviour changes on the ground (e.g. flood-proofing pit latrines by building them on raised platforms; digging deeper boreholes for water supply in a drought; etc.) to complex policy and governance arrangements that build broader adaptive capacity on the national or company-wide level (e.g. disaster risk management planning for water utilities; integrating climate impacts into water safety planning; etc.). But, as the climate risk management (CRM) sector has developed, it has also become clear that, without proper foresight and planning, some actions taken to supposedly adapt to climate impacts could end up actually increasing climate vulnerability, either of the system itself or as a negative externality on neighbouring systems (i.e. resulting in 'maladaptation') (Barnett and O'Neill, 2010). This maladaptation could occur because of the failure to properly consider: the best available projections of climate impacts, local contexts, policy arrangements, or other related issues. For example, drilling improperly-cited boreholes to decrease water supply vulnerability could end up increasing it, if these boreholes tap into an already depleted aquifer or if they are located in a flood-prone area.

As a result, a very wide variety of management tools and approaches are being actively created by stakeholders in the development, climate and WASH sectors, with the stated aims of helping users to navigate the complexity of climate science and avoid maladaptation. From a practitioner's viewpoint, it is rare for a month to pass without learning about some sort of new, so-called 'tool' that claims to fill a particular niche and add new value for its stakeholders.

Yet, this rapidly growing range of available tools is not necessarily a good thing. Without perfect information, this growing variety creates the risk of overwhelming potential tool users, and thus resulting in inefficiencies in tool selection and use that defeat the purpose of having them in the first place. Likewise, tool developers risk wasting time in developing 'new' tools that have essentially already been created in a very similar form elsewhere, where their time could have been better spent on improving or scaling-up these existing tools.

This paper thus aims to attempt a comprehensive *(but not exhaustive)* review of – and subsequent reflection on – the full range of existing 'tools' on CRM that could be applied to WASH services. Some guiding questions that have motivated this assessment include:

- What is a useful definition of a 'tool' for climate change and WASH?
- How can different types of tools best be arranged and classified?
- Knowing this, approximately how many 'tools' of this nature already exist?
- To what extent does each of these tools serve a specific 'niche', or is there a significant degree of overlap between many of them?
- Is there evidence of strong user demand for climate/WASH tools, especially within developing countries, or is development and promotion largely a supply-driven market?
- What types of tool best engage their users, and how could better tool design encourage a scaling-up of tool use?

Doing this will hopefully offer some degree of structure and clarity to the 'tool industry' of both developers and users, while also offering advice to influence whether and how new tools are created, how both new and existing tools could be made more efficient and effective, and how users can best navigate and choose tools of most value to them.

1.3 Scope and Methodology of the Study

The focus of this study was on reviewing tools that in some way facilitate CRM specifically for WASH services, framed within the broader 'water sector'. An undertaking of this type presents a number of challenges and caveats. The most important one was the need to carefully and appropriately define the meaning of a 'tool' in this context, which will inevitably be a controversial undertaking. In the process, other definitions, like 'climate adaptation', 'CRM' and 'WASH' need to be clarified as well. There are literally hundreds of self-defined CRM-related 'tools' that could be at least tangentially relevant to this topic, ranging from complex computer models to general management principles. At the same time, there are many more documents / guidelines / packages / approaches that present themselves in a very similar fashion, but do not necessarily refer to themselves as 'tools'. An ideal definition would thus take both groups into account, while also considering the definitions used by previous authors and attempting to strike an appropriate balance between specificity and generality.

In terms of the method, a full systematic review to identify as many candidate tools as possible, followed by in-depth analysis of each, would have been ideal, though this was unfortunately not feasible with the available time and resources for this work. The methodology used was thus an ordinary literature review,[5] and the candidate tools identified were each given only a lighter level of analysis. This study therefore does not at all claim to be exhaustive in the list of tools that it generated. While not ideal, this method nonetheless generated a sufficiently comprehensive review for the purposes of reflecting on the current state of the 'tool industry' and recommending some appropriate ways forward.

Finally, it is important to also note that there exist several previous reviews and assessments of these types of CRM tools, which will be discussed further below. These have mainly focused only on smaller numbers of general CRM tools though, and only rarely attempt the same kind of holistic analysis that we undertake here. Our study thus adds value through its focus on tools for WASH and its attempt to broadly review and analyse as many of these relevant tools as possible. The lessons and recommendations that we draw will also be valuable for readers beyond just the WASH sector, as many apply to the tool industry more generally.

1.4 Summary and Outline

This chapter provided an introduction to WASH and climate change and described the study that we carry out here. It emphasised the importance of building WASH resilience to both current climate variability and future climate change, highlighting previous findings that suggest that the best way to do this is often by simply promoting good general management

[5] This review was broadly undertaken using Google (both its regular Search page and its Scholar page), as well as by forward- and backward-searching based on key existing reviews and tool databases. As this work was undertaken sporadically over several months, during this time, several newly created candidate tools were also identified via sectoral mailing lists / news feeds. Note also that no spatial or geographical restrictions in scope were applied to this study. The study accepted tools designed for any scale (international / national / local), any country (including developed world nations), any circumstance (urban / rural), any topic within WASH, and/or any stakeholder (government / civil society / water service providers / etc.). Note though that only English-language tools were reviewed, which was a weakness in terms of the review's breadth. That said, none of the other tool reviews undertaken to date mention any abundance of non-English tools, so their number may be minimal.

of WASH service provision. This is especially because of the difficulty in defining future climate conditions with adequate precision and accuracy at the scale of most water management activity, a condition which is unlikely to change in the near future.

The remainder of this study will consist of five additional chapters. Chapter 2 will generate a relevant definition for a climate/WASH tool and then adopt a suitable categorisation system for these tools. Chapter 3 will discuss our review of these tools, first synthesising the results of previous reviews, and then discussing our broader review itself, following with some summary statistics and examples of specific tools. Chapter 4 is essentially the 'discussion' section, and will focus on three general lessons learned from this review, relating to the degree of existing tool overlap, the evidence for user demand, and the main design challenges facing new tool ideas. Chapter 5 then distinguishes itself by presenting our short, focused recommendations for tool users and tool developers. If you reside in either category and only have time to read one chapter of this study, we recommend that you read this one. A lengthy annex then follows where every tool that we reviewed is presented, referenced and categorised.

2 What is a 'Tool' for Climate and WASH, and What Types Exist?

This chapter aims to generate a relevant definition for a climate-WASH tool and to then adopt a suitable categorisation system for these tools. This will first entail discussions: on the uses of the word 'tool' by previous authors; on defining 'climate adaptation', 'CRM', 'WASH' and 'tools' for CRM-WASH; and on how this new definition of a tool then fits in with other previous definitions. The chapter will then discuss how these tools can be classified, making use of an existing typology by previous authors while also adding some new insights for the WASH context.

2.1 Basic Definitions

For clarity, we briefly define two important terms used here – climate adaptation and CRM – and distinguish between WASH and the broader 'water sector'. The traditional definition of climate adaptation relates to 'initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects' (IPCC, 2007). In contrast, Hammill and Tanner (2011) define CRM as 'the systematic approach and practice of using climate information in development decision-making so as to minimise potential harm or losses associated with climate variability and change'. Given that CRM is the more holistic term, and essentially incorporates adaptation to future impacts along with resilience[6] to current climate variability, it is the term mainly used here, except when the adaptation concept needs a specific focus.

We then do the opposite for the WASH and water sector terms, where we focus here on WASH services as one aspect of the broader water sector. Although a concept as broad as the 'water sector' will never be able to be fully bounded by a definition, a useful framework for it recently emerged in the post-2015 water negotiations. There, the sector has been thought of as consisting of three (somewhat overlapping) parts: basin-level water resources management (WRM); user-level water supply, sanitation and hygiene services (WASH); and service provider- / government-level wastewater management and water quality

[6] Note that, given the variety of different conceptions of the term 'resilience' (Levine et al., 2012), we choose not to define it explicitly here. Many of the tools reviewed in this study take different conceptions of the term as well, and in many cases these conceptions may conflict with each other. Thus, when screening candidate tools with the definition that we generate below – which contains 'resilience' within it – we do not discriminate based on the specific conception of 'resilience' that is used, as long as it is clearly operational and linked to WASH.

(WWMWQ).[7] We focus here on tools that could promote CRM specifically for WASH services, though recognise that some of the overlap between these parts could translate into overlapping tools as well, so we assess this WASH-relevance for tools from across the water sector. That said, we ended up finding a substantial degree of overlap in our review, and ultimately excluded only a couple of tools due to their strong WRM focus.

2.2 What is a Climate-WASH 'Tool'?

The concept of a 'tool' is broadly used and takes various meanings, with many conflicting understandings of what a tool is in different contexts. Even when looking only at definitions for climate/water sector tools, this remains to be the case, with the possible spectrum of so-called 'tools' ranging from technology all the way to broad political frameworks. The one end of this spectrum includes authors like Palaniappan et al. (2008, pp. 3-4), who, in their review of WASH-related tools, define the term as 'the technologies, financing strategies and approaches that are being used in the WASH sector'. That is, this definition would include technologies like pit latrines and activities like microcredit lending as 'tools'. Meanwhile, at the other end of this spectrum, authors like UNDP Cap-Net (2009) define integrated water resources management (IWRM) – a broad political concept or ideal, at best – similarly as a 'tool' for climate adaptation.

In our opinion, neither of these extremes of the spectrum are 'tools', as they both lack any clear practicality to individual users. To use an analogy: in general English language usage, one may often associate the word 'tool' with hand-held construction equipment, like hammers or screwdrivers.[8] There is usefulness to this fact for the climate-WASH context, as hammers and screwdrivers are 'tools' because of their clear practical purpose and simple user interface. The average construction worker, however, would very likely not claim that national building codes (e.g. Cap-Net's IWRM) – or the constructed building itself (e.g. Palaniappan's technology) – were 'tools'. Clearly, defining a tool this broadly could end up including almost anything as a 'tool', which would defeat the purpose of using the term at all.

An ideal definition therefore needs to strike a more appropriate balance between specificity and generality, in order to define a useful range of practical 'tools', but to exclude those things that cannot immediately be compared to hammers and screwdrivers in terms of their practicality. Practicality of what, though? In this climate-WASH context, the focus is on those tools that somehow promote or implement CRM for WASH services, which obviously makes the definition specific to this context, though this could be easily modified for other contexts.

With all of this in mind, we define 'tools' in this context as, '***documents, computer programmes or websites that clearly and thoroughly operationalise a set of principles or practices that could build the resilience of WASH services to current climate variability or future climate impacts, preferably in an engaging and user-friendly manner'***. This definition builds on those proposed by the UNFCCC (2008) and Hammill and Tanner (2011), though focuses more directly on the need for these tools to have a practical operational purpose. This includes the final clause on user engagement, which is not strictly necessary in the definition, but is included to draw attention to its importance, since, as will

[7] That said, this framework still explicitly omits other important water-related areas like flood and drought risk management, though they could mainly be implicitly managed within each of these three parts. Likewise, we can also brand the 'water sector' more generally as consisting of individuals and institutions that are directly or indirectly involved in some form of water management, since WASH practitioners do not always associate themselves with the traditional conception of the 'water sector' (i.e. WRM and so-called 'nexus' topics).

[8] Indeed, the first definition of a 'tool' in the Oxford English Dictionary (Pearsall, 1999) is 'a device or implement, typically hand-held, used to carry out a particular function'.

be discussed in Chapter 4, this element is often sorely lacking. We thus use this definition in Chapter 3 to screen potential candidate tools[9] for inclusion as 'CRM tools for WASH'.

We believe that this definition is useful because it balances generality and specificity, with a clear operational criterion in place. This criterion is particularly important for setting the scope of the tool review in Chapter 3, since there are a huge number of reports and policy documents that may include recommendations or best principles that could, if implemented, increase WASH resilience to climate impacts. If an attempt was made to include them all here, there would literally be thousands of entries to review. But if these documents themselves do not describe how *specifically* to go about implementing these recommendations, then they are excluded by this definition, which narrows the possible pool of candidate tools considerably. Also note that while this definition excludes static technology, it *can* include tools designed to assist in technology choice, as these are specific operationalisations of a set of recommendations. It could likewise include tools designed to provide guidance on how to specifically implement IWRM principles.

2.3 Classifying Tools

A wide variety of tools will fit our proposed definition, so it is also useful to discuss how they can be classified after being officially assessed as 'tools'. There are no firm rules about this, nor any driving theory, but simply a desire for better organisation of the resulting tool lists. In this regard, we have observed tools being classified by their *function* or by their *sector*, amongst other ways.

2.3.1 Functional Classification

A useful and relevant functional classification scheme was generated by Hammill and Tanner (2011, pp. 17-20). They define three functional 'types' of tool:

I. Process guidance tools, which 'guide users through the implementation of one or several steps in the CRM process'
II. Data and information provision tools, which 'generate or present information that can be used as inputs for implementing one or several of these process steps'
III. Knowledge-sharing tools, which 'allow users to share knowledge and experience to inform, support and refine the implementation of these process steps'

They then sub-categorise the first type (process guidance) further, based on the various potential functions of these tools. They highlight that these tools can perform functions related to:

- Communications and engagement with stakeholders
- Screening of the development activities for climate risks
- Assessing in greater depth the climate risks and potential adaptation / response options for those activities identified via screening
- Assisting with the implementation of the selected options
- Assisting with the monitoring and evaluation of the selected options

[9] Note that the consideration of whether something fit this definition was done independently of whether or not it currently defines itself as a 'tool', since there are many existing 'methods' / 'support resources' / 'approaches' / etc. that could fit this definition and similarly many self-defined 'tools' that could not.

While this classification scheme does suffer from some potential overlaps (i.e. a tool could be both Type 1 and 2), it is nonetheless useful for organising tools based on these potential functions. Altogether, they summarise their typology in Figure 1.

2.3.2 Sectoral Classification

Another useful way to classify tools is by their sector. Given this climate-WASH context, we propose the following classification scheme to account for the various 'sectors' within this context. We can first think of there being three relevant sectors whose tools would be useful for this context:

1. tools for 'general' CRM that do not necessarily mention water sector issues anywhere, but that may still be usefully applied to this context
2. tools for water sector best management that do not necessarily mention CRM, but whose use could indirectly improve the resilience of water sector services to climate impacts
3. CRM tools designed specifically for water sector services

Then, within these three broad classifications, further sub-classification could be made for tools targeted specifically to the three parts of the water sector: water resources management (WRM), WASH, and wastewater management and water quality (WWMWQ). This sub-classification is used here, since we are mainly interested in WASH-related tools. Within or alongside this, further sub-classification could also be made based on the *spatial scale* of these tools (local, state-level, national or transboundary), on the specifically stated *audience* for these tools (e.g. community members, policy-makers, NGO workers, service providers, etc.), or on the *methods used* or *outputs generated* by these tools. Any or all of these sets of sub-classifications could be used simultaneously or independently, depending on the purpose of the classification exercise. That said, none of them are necessarily exclusive – for example, a tool could easily be relevant for both WRM and WASH, for both local and national scales, and/or for both community members and policy-makers. Together, this classification scheme is summarised in Figure 2.

2.3.3 Issues

While both classification schemes are useful, none of their categories are totally independent and mutually exclusive from the others. As mentioned, a single tool can often perform a variety of different functions and be designed to be relevant for a variety of different audiences or sectors. For example, a single tool could perform both communication and screening functions, and be relevant for both WRM and WASH, across both local and state-level scales, and able to be used by either community members or NGO workers. This should not necessarily be cause for concern, as it simply indicates versatility in the tool across a wider range of functions and audiences. For the purposes of the review in Chapter 3, the main point of focus was thus not on whether each tool was perfectly classified, but rather on ensuring that each candidate tool that was assessed met the overall definition of a 'tool' for its inclusion in the list.

2.4 Summary

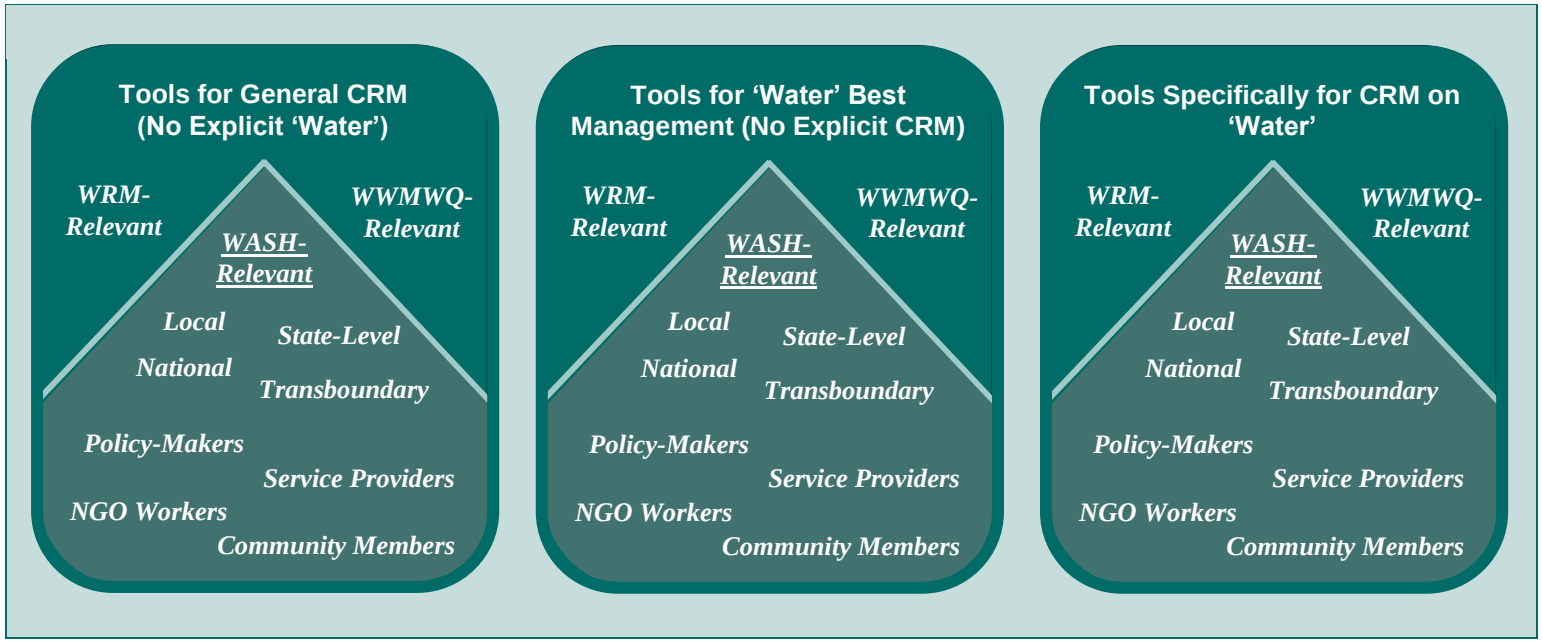
This chapter set out the main definitions for use in the rest of the paper, then discussed ways of classifying tools. It defined the terms of climate adaptation and climate risk management, where the former is one aspect of the latter, which also includes resilience-building to current climate variability. It then clarified the meaning of the 'water sector', identified the place of WASH within this, and proceeded to define a 'CRM tool for WASH' as something with a clear operational aspect, to engage users in building climate resilience for WASH services. It then discussed two different ways to classify tools: by their function and by their sector, both of which will be used now in the next chapter to review existing climate-WASH tools.

Figure 1: Hammill and Tanner's (2011) functional typology of tools, with their links to the CRM process and to typical policy and project cycles.

Climate risk management / Adaptation Tools				Climate risk management / Adaptation Process	Development decision-making processes	
Type 3 Knowledge Sharing Tools	Type 2 Data & Information Tools	Type 1 Process Guidance Tools			Policy Cycle	Project Cycle
Web-based platforms, offering access to: ▪ Relevant news (e.g. media stories, recent meetings) ▪ Scientific, policy, project documents (e.g. journal articles, case studies, reports) ▪ Personal observations and experiences (e.g. blogs, forums) ▪ Professional networks ▪ Type 1 process guidance tools ▪ Type 2 Data & information tools	▪ Climate information primers	Comprehensive process guidance tools	Communication Tools	**Awareness ↑ / Engagement**	Policy formulation	Project identification
	▪ Primary climate info: - Current temp and rainfall data, maps - Projections (GCMs, downscaling tools) ▪ Secondary impact models, maps ▪ Vulnerability info - Poverty, livelihood, socio-econ data		Screening Tools	**Pre-Screening**		
				Screening		
			Assessment Tools	**Risk Assessment**		Project appraisal
					Planning	
				Risk Analysis		Detailed design
				Options Evaluation		
			Implementation Tools	**Implementation (integration / design)**	Resource allocation	Implementation
					Programming / Implementation	
			Monitoring & Evaluation Tools	**Monitoring & Evaluation**		Monitoring & Evaluation

Source: Hammill and Tanner (2011)

Figure 2: A sectoral classification scheme for tools, displayed in Venn diagram format and also showing its relationship to potential sub-classifications of spatial scale and audience (similar sub-classifications would exist for WRM and WWMWQ)



Source: Author's own

3 How Many Tools Exist and What Types of Service Do They Offer?

This chapter aims to overview existing, relevant reviews of tools from the literature and to then broadly review and analyse as many more tools as we could find. Several previous reviews have been undertaken, but focused either on deeply analysing a small number of tools or on simply listing a larger number of tools without accompanying analysis, and none have also yet focused on the climate-WASH linkages. The tools from these reviews are extracted and added to the list of the many other tools discovered during this study. Some summary statistics of this final tool list – based on Chapter 2's classification schemes – are then discussed, along with some examples of these various types of tools.

3.1 An Overview of Existing, Relevant Tool Reviews

Based on the literature review conducted for this study, there are at least 11 previous, relevant climate-related reviews of 'tools' that include some CRM tools for WASH, of varying size and scope. There are definitely more than 11, but any reviews older than 2008 were essentially ignored, as it was assumed that at least a few of these more recent reviews would have accounted for them.[10] Assessing them based on their sector, eight of them focus mainly on Figure 2's so-called 'tools for general CRM'. Two of them focus on tools relevant to all three types of sector, and the remaining one deals mainly with 'tools for water best management' and 'tools specifically for CRM on water'.

Table 1 summarises the varying tool details collected by these reviews, to give an indication of their depth of analysis. As mentioned earlier, most tended to focus on analytical depth or categorical breadth, whereas we attempt to do both here. As well, even when their findings are combined, the results are still not comprehensive across all the climate/WASH tools of interest. Note as well that not every 'tool' identified by these reviews meets our own definition of a tool here, and those that do not are excluded from the lists below.[11] For example, some of the tools from these reviews that are specific to an entirely different

[10] There are also some reviews, such as the one by Ecofys and IDS (2011), that review a few adaptation tools, but also many tools related to climate change mitigation and renewable energy topics. Reviews like these have also been ignored, as the few adaptation tools they review are covered by these existing 11.

[11] This screening process – which was also applied when collecting new tools beyond these reviews – relied solely on our proposed definition, and gave the benefit of the doubt when necessary. That is, unless a 'tool' clearly did not fit in our definition, we included it in the lists. That said, the process was inherently based on our own expert judgement, with others likely able to arrive at different results by screening with the same definition. While we would not expect the variation to be large, it should be understood that the number of tools listed here could vary slightly if reproduced by a different practitioner.

sector (e.g. agriculture) are not discussed here, as they do not meet our definition of a tool in this context. This was one of the main reasons for exclusion of candidate tools from these reviews, with the other being candidates that lacked a clear operational focus.

The eight 'general CRM' tool reviews were undertaken by GIZ (2009), OECD (2009), Olhoff and Schaer (2010), Traerup and Olhoff (2011), Hammill and Tanner (2011), the Caribbean Community Climate Change Centre's (CCCCC) Caribbean Climate Online Risk and Adaptation Tool (CCORAL) website (2013), the Stockholm Environment Institute's (SEI) weADAPT website (2013) and the UNDP's Adaptation Learning Mechanism (ALM) website (2013). The GIZ (2009) review is a conference report from a CRM tool review event. Its annex also reviews 15 'tools', though only 10 fit our tool definition here. The OECD (2009) review is a summary review of the broader aspects of CCA for development. Its annex also reviews eight 'tools', though only four fit our tool definition here. The Olhoff and Schaer (2010) review is a focused review of general CRM tools. It reviews and discusses 29 tools in considerable detail, though only 12 fit our tool definition here. The Traerup and Olhoff (2011) review is another focused review of general CRM tools. It reviews and discusses 15 tools in detail and also gives examples of their use in the WASH sector, though only eight fit our tool definition here. The Hammill and Tanner (2011) review is yet another focused review of general CRM tools that also defined the functional tool typology used here. It identifies 29 tools and reviews nine in considerable detail, though only 17 fit our tool definition here. The CCCCC's CCORAL (2013) review is presented in the form of an online 'toolbox', reviewing 73 'tools', mainly targeted for general CRM in the Caribbean, but 31 still fit our definition here. SEI's weADAPT (2013) website reviews at least 47 general CRM tools across various pages of its website, though the website is still continually being updated, so its numbers and content are subject to change. Only 18 of its tools fit our definition here. Lastly, the UNDP's ALM website is very similar to weADAPT, and has at least 76 resources tagged as 'tools' (mainly general CRM), though only 18 of its tools fit our definition here.

The two reviews that focused on all three types of tool sector were undertaken by Garg et al. (2007) and UNFCCC (2008). The Garg et al. (2007) study reviewed 95 'tools', including complete toolkits and individual tools for climate impact assessment and adaptation activities, as well as a variety of sector-specific tools, including those for the water sector. Of these 95, only eight fit our tool definition here. The UNFCCC (2008) study was very similar in style and content, reviewing 131 'tools' from a similar variety of sectors. Of these, only 16 fit our tool definition here.

The one review that focused on tools for 'water best management' and 'specifically for CRM on water' was undertaken by Palaniappan et al. (2008). Palaniappan et al. (2008) identified 120 'tools' – mainly on water sector best management – then reviewed 18 in detail, though only 22 fit our tool definition here.

These reviews serve useful purposes. Some, like Olhoff and Schaer (2010) and Hammill and Tanner (2011), go into considerable detail on individual tools, analysing their design and structure for different audiences. Others, like weADAPT, ALM and CCORAL are less detailed as reviews, but have a second function as individual tools themselves (of the 'knowledge sharing' category), so are included both here in Table 1 as reviews and in our individual tool review below as tools. All of them (including our own review, below) can also be considered a type of 'meta-tool' – encouraging more thoughtful discussions of tools and their strengths/weaknesses in different contexts. This will be discussed further in Chapter 4.

Table 1: Summary of tool details collected by the 11 existing reviews

GIZ 2009	OECD 2009	Olhoff and Schaer (2010)	Hammill and Tanner (2011)	Traerup and Olhoff (2011)	CCCCC CCORAL (2013)	SEI weADAPT (2013)	UNDP ALM (2013)	Garg et al. (2007)	UNFCCC (2008)	Palaniappan et al. (2008)
Total Number of 'Tools' Reviewed (Number of Tools Conforming to the Climate/WASH Definition Here)										
15 (10)	8 (4)	29 (12)	29 (17)	15 (8)	73 (31)	~47 (18)	~76 (18)	95 (8)	131 (16)	120 (22)
Tool Details Collected										
Name of the tool	Name of the tool	Name of the tool	Name of the tool	Name of the tool	Name of the tool	Name of the tool	Name of the tool	Name of the tool	Name of the tool	Name of the tool
Designer organisation	Operational organisation	Designer organisation	Designer organisation	Designer organisation	Description	Description / Examples	Country	Strengths	Designer organisation	Authors
Short description	Short description	Short description	Short description	Short description	Accessible to non-experts?	Case Studies	Theme	Weaknesses	Short description	Short description
Target user group	Where and when applied so far	Target user group	Target user group	Target user group	Multi-modular / end-to-end?	Related content (themes, organisations, networks)	Type	References	Appropriate use of tool	Year published
Cost of the tool to use	Link to the tool / references	Methodological approach	Which sub-type(s) of type 1 tool is it?	Methodological approach	Free to use?	Links / references	Leading organisation		Target scale of use	Publisher
Time needed to use it		Target scale of use	Target scale of use	Target scale of use	User friendly?		Funding source		Key inputs needed	Number of pages

Is the tool mandatory or voluntary in the designer organisation itself		Does the tool include a costing exercise	Is the tool mandatory or voluntary in the designer organisation itself	Does the tool include a costing exercise	Designer organisation		Date	Key outputs from the tool	Link to the tool / references
Level of climate expertise needed		Where and when applied so far	Key inputs needed	Link to the tool / references	Year published		Tags	Key sub-tools within the tool (if applicable)	
Is the tool web based		Link to the tool / references	Key outputs from the tool		Language		Summary of the tool	Ease of tool use	
Screenshots of the tool in action		Long description (in annex)	Long description (in main text)		Tool type		Link to the tool	Is training required? Is training available?	
Link to the tool / references			Link to the tool / references		Target audience			Computer requirements	
Relevant point of contact					Sector			Where and when applied so far	
					Geographic coverage			Cost (both of tool and of using it)	
					Relevance to activity / decision type			Relevant point of contact	
					Link to the tool			Links / references	

3.2 Results of this Tool Review

These 11 existing reviews served as the beginning of the climate/WASH tool review carried out here, but, as mentioned before, their overall list of tools was not comprehensive even when combined, so further review was necessary. It is worth reiterating our screening criterion to undertake this review, which relied solely on our best judgement as to whether a potential tool strictly fit our climate/WASH definition. The only other filter we applied was to exclude any otherwise suitable tools from the previous 11 reviews that were no longer locatable on the internet. This resulted in the exclusion of several tools from the list, likely around 5% of the total. Nevertheless, we identified 137 existing tools that met our climate/WASH definition, 46 of which had not been previously reviewed by any of these 11 reviews. The full list of these, along with our attempt to classify them, is displayed in Annex 1.

While this total number of 137 may sound a bit small compared to UNFCCC (2008) and Palaniappan et al. (2008), this number reflects only those 'official' tools that passed our screening definition. Although we did not attempt to record every candidate 'tool' that we assessed and rejected, there was a large number of them, potentially between 500-1000. Looking at the proportions of useful tools gained from each of the 11 reviews gives some indication, where the overall average proportion of useful tools gained was only ~38% of the total number of 'tools' that they reviewed, though the proportions for the larger reviews were even smaller, at 12% for UNFCCC (2008) and 18% for Palaniappan et al. (2008). We judge these results to be similar to our own research for candidate tools beyond these 11 reviews, which makes sense when considering the specific climate/WASH topic of focus here compared to the number of tools available for other sectors and audiences. Also note that this number of rejects is not particularly important or meaningful. It simply represents those 'non-tools' that were close enough contenders to actual 'tools' that we needed to assess them, yet, in theory, *every* document, computer programme or website that does not fit our definition is equally 'not a tool'.

Some summary statistics of this review are displayed in Table 2. As is also described in the annex, we used both functional and sectoral classification schemes to organise the tools that passed our screening definition, based on our own best judgement. In both this table and in the annex, '1 / 2 / 3' represents the three functional tool types as described in Figure 1: process guidance tools, data and information tools, and knowledge sharing tools. Likewise, 'A / B / C' represents the three sector types as described in Figure 2: tools for general CRM, tools for 'water' best management, and tools specifically for CRM on 'water'. Combining the two classification schemes allowed for nine different categories of tools, as visible in the table. An important thing to note in Table 2 is that the individual category tallies do not sum up to the total number of tools (e.g. 107 + 17 + 15 = 139 ≠ 137), due solely to the fact that a couple of the tools were able to take on more than one classification (e.g. able to be both a '1-B' tool and a '3-B' tool).

As visible in this table, the number of tools of each type varied significantly. Looking first at the functional typology, the vast majority were of the type 1 category. This is mainly due to a positive bias in our definition towards this type of tool, focusing on those tools with a clear operational aspect for addressing CRM for WASH. Many of the potential type 2 and 3 tools that we examined were simply less capable of supporting this narrative and were thus excluded. For example, there are a huge number of potential type 2 tools that undertake climate impact projections in various different ways, but almost none of them were included here, as their clear and direct operational links to WASH resilience were simply too weak. As another example, many more type 3 tools could have been added if we had included climate/WASH-related formal learning courses (whether classroom-based or e-learning). These could have fit into our definition, but we excluded them due to their transience (courses can change yearly), inaccessibility to the general public (if they require a competency-based study application), and general complexity, requiring too many value

judgements (e.g. would a climate/WASH module within a larger course be enough to classify the whole course as a relevant tool?).

Looking next at the sectoral typology, the numbers are more evenly spaced. General CRM tools and water sector best management tools were approximately equivalent, while there were fewer tools designed specifically for CRM on WASH, which makes sense. From a stakeholder perspective though, these type C tools are likely the most useful in most circumstances, so are worth special attention by potential tool users.

Table 2: Summary statistics from the tool review

Total number of unique climate/WASH tools = 137		
Total number of tools not previously reviewed = 46		
Number of 1's = 107		**Number of A's = 58**
Number of 2's = 17		**Number of B's = 52**
Number of 3's = 15		**Number of C's = 29**
Number of 1-A's = 50	**Number of 2-A's = 1**	**Number of 3-A's = 7**
Number of 1-B's = 38	**Number of 2-B's = 11**	**Number of 3-B's = 5**
Number of 1-C's = 20	**Number of 2-C's = 7**	**Number of 3-C's = 3**

3.3 Some Examples of Tools

With that in mind, it is worth now discussing a few examples of tools from the different categories, to illustrate both their typical characteristics and the reasons why we judged them to fit within our definition. We will very briefly discuss one example from each of the nine categories.

3.3.1 Category 1-A Example: Community-Based Risk Screening Tool – Adaptation and Livelihoods (CRiSTAL)

The CRiSTAL tool, developed by IISD and partners, is probably one of the best known and most widely used general CRM tools. As a tool that targets local project planners, it focuses on identifying and prioritising climate risks for projects at the local level, while also helping users to identify the most important local livelihood resources for use in designing adaptation interventions. It was originally piloted in 2004 and is continually updated, now on its fifth version. It has been applied in over 20 countries across Asia, Africa and Latin America, including in the water sector. Its broad array of documentation and practical resource material definitely qualifies it as a tool here, and its focus on general CRM, though with several examples of previous application to water management issues, allows it to be categorised as a type 1-A tool here.

3.3.2 Category 1-B Example: Water Safety Planning (WSP)

The WSP concept is an initiative of the World Health Organisation (WHO), which created a detailed guidebook for the process in 2009. WSPs have the main aim of consistently ensuring the safety and acceptability of a drinking water supply, and are versatile in their ability to do this for anything from a simple groundwater well to a complex treatment and distribution system. The strength of this tool has been its comprehensive and detailed risk assessment and management methodology, which takes stakeholders through all the steps in the water supply chain from source to consumer, to proactively identify risks before they occur. This clearly categorises the tool as type 1, while its general focus on water supply

then categorises it as type B. That said, the explicit risk management process that it undertakes could certainly help build water supply resilience to climate variability and change, even if climate change impacts are not explicitly considered as risks (though they are certainly able to be). This thus ensures its qualification as a tool here.

3.3.3 Category 1-C Example: Rapid Climate Change Adaptation Assessment for WASH Providers in Informal Settlements

A newer tool developed by Heath et al. (2012) is the Rapid Climate Change Adaptation Assessment (RCAA). This tool was developed specifically to assess climate vulnerabilities and recommend appropriate adaptations for the WASH sector in urban slum communities, and has been trialled in three such slums in Africa. Its method consists of initial risk screening, impact modelling, and subsequent risk analysis and management. While the modelling portion of the tool might suggest a type 2 classification, because its purpose was still focused on the risk assessment and management, we classified it as type 1. Its specific design for CRM on WASH easily classifies into the type C category. While the Heath et al. (2012) literature documentation is not particularly detailed, it still had enough of an operational element to ensure its qualification as a tool here.

3.3.4 Category 2-A Example: SimCLIM

SimCLIM is an integrated computer modelling system that can be used to assess climate impacts and adaptations. With a wide variety of available data, plus a high degree of customisability, the software is versatile enough to support climate-related decision making and CRM across many different locations and sectors, including the water sector. Developed by CLIMsystems Ltd., the tool requires purchasing, but, after this point, arrives with detailed documentation that qualifies it as a tool here. Its nature as a computer model classifies it into the type 2 category, while its general CRM focus – though with stated applicability to the water sector – likewise classifies it into the type A category.

3.3.5 Category 2-B Example: Water Security Index

The recently developed Water Security Index by Asian Development Bank (ADB) / Asia-Pacific Water Forum (APWF) illustrates that not all type 2 tools are pieces of computer software. Located in the appendix of an accompanying report for policymakers (ADB and APWF, 2013), this detailed methodology is described for how to measure national progress towards water security. ‘Water security’ in this report is composed of five parts: household water security, economic water security, urban water security, environmental water security, and resilience to water-related disasters, all of which received numerical scores for each country assessed, and with each score based on a variety of supporting subordinate data. While presented here at the country-level, the described methodology could be easily downscaled to similarly assess provinces/states or municipalities, contingent on data availability. The clear comparative usefulness of the resulting scores, as well as the usefulness of gathering the relevant supporting data, gives the tool a strong policy-relevance and its results could likely inspire policy change to achieve better water security, which includes improving WASH services and their climate resilience. Thus, the detailed methodology and its use as an advocacy tool for improving WASH resilience are enough to qualify it as a tool here, with its data analysis-focus for water sector best management categorising it as a type 2-B tool.

3.3.6 Category 2-C Example: Water Evaluation and Planning System (WEAP)

Returning to computer software, the Water Evaluation and Planning System (WEAP) software, developed by the Stockholm Environment Institute (SEI), is similar to SimCLIM, but focused on water resource planning. It can build a model of the current water resource conditions in an area and then can explore various scenarios related to overall supply and demand, such as new reservoirs, population growth, or water use patterns. It can do so from a water balance perspective or from a policy perspective, and although it was not designed specifically for climate adaptation, it nonetheless has seen a lot of useful application to adaptation planning in WASH, with some users using it specifically for this purpose. Unlike

SimCLIM, the software is also free under some license and use conditions and is another of the most widely used tools, available in 22 languages and with nearly 12,000 members on its discussion forum as of July 2013. This clearly gives it a strong user support base and operational focus, which qualifies it as a tool here. Its modelling focus for the water sector, including climate adaptation aspects, then categorises it as a type 2-C tool.

3.3.7 Category 3-A Example: weADAPT

As mentioned earlier, SEI's weADAPT web platform serves as a knowledge sharing tool in addition to its role as one of the 11 existing tool reviews. The website focuses on all things climate adaptation, and includes related reports, organisations, tools, projects/programmes, and various data. Its moderated wiki format also allows anyone to sign up and add their own content to the database, such as new tools or projects. Its content includes many water-related tools, reports, data and projects. This type of knowledge-sharing environment categorises it well as a type 3 tool, with its adaptation focus – including applicability to water issues – categorising it as a type A tool. Its inclusion of a wide variety of practical guidance documents and its focus on adaptation and risk management qualifies it as a tool here.

3.3.8 Category 3-B Example: Global Water Partnership (GWP) toolbox for integrated water resources management (IWRM)

The GWP toolbox on IWRM serves to share knowledge on 61 different methods for better accomplishing an IWRM process, along with a variety of case studies, example IWRM plans and policies, and links to partners and other relevant publications. While the focus is on IWRM, many of its recommendations and methods are also applicable to WASH services, and resources on climate adaptation are also available. A case could thus be made that this tool fits in the type C category, but since its driving focus is mainly on IWRM, we judged it more suitable in type B. Its nature as a content-heavy website, with focus on practical guidelines, likewise gives the type 3 category. It fits our definition of a tool because of this availability of practical guidelines, its relevance to WASH, and its relevance to climate adaptation.

3.3.9 Category 3-C Example: Technologies for climate change adaptation – the water sector

Lastly, the UN Environment Programme's (UNEP) handbook on technologies for climate adaptation in the water sector is an example of a type 3-C tool. This handbook presents a variety of WASH-related technologies and discusses when, where and how they can be best-adapted against climate variability and change. Note that the technologies themselves are not tools, but a decision support manual of this nature can indeed qualify as a type 3 tool. Because the technology focus is specifically on WASH technology climate resilience, the handbook fits a type C categorisation. It qualifies as a tool because of its practical guidance and specific focus on promoting climate/WASH technology resilience.

3.4 Summary

This chapter discussed the tool review that we performed. It first focused on the characteristics of the (at least) 11 previous reviews of potentially relevant tools that had been performed, emphasising that few had attempted as holistic of a review as the one we performed here and that none had focused specifically on the topic of CRM tools for WASH. It then discussed the characteristics of the 137 tools in total that met our climate/WASH definition, noting that the majority were functionally 'process guidance' tools, due to the focus in our definition on tools as having a clear operational focus. It then concluded by reviewing one example from each of the nine categories used to classify the tool list here. The next chapter will now draw out lessons learned from the process of reviewing these 137 tools and the many additional, rejected candidates.

4 Lessons Learned from the Tool Review

This chapter aims to draw out lessons from this tool review, to reflect on the study questions posed in Chapter 1 and to assess the evolution of the 'tool industry' to date. It begins by considering the extent to which these various tools do or do not overlap in their audience and function, and whether the number of current tools is sufficient to meet the needs of most potential users. It then assesses whether there is any evidence of user demand for these existing climate/WASH tools, especially within developing countries, or whether the tool industry has mainly been a top-down, developed world-driven process. It concludes with a focus on tool design, considering how tools can best engage their users and how better tool design could encourage a scaling-up of tool use.

4.1 An Abundance of Tools – Are They Fit for Purpose?

The existence of at least 137 tools that could help bring about resilience of WASH services to climate variability and change raises the question of whether or not this is indeed a relatively large number of tools for the context. In other words, do many of these tools overlap, with all possible niches already full, or are most of them unique, with many more potential niches remaining to be filled? If we rely only on the data of the nine possible categories in Table 2, a relative abundance of type 1 tools is clearly visible, but this alone does not really satisfy the question. A better answer could be achieved if each tool was given further subdividing classifications, such as classifications based on their spatial scale, methodology used, possible audiences, possible outputs, and so on.[12] This would create many more overall categories of tools and allow the results to better indicate how evenly distributed the tools were across all these categories.

The major downside to this, though (i.e. the reason it was not attempted here), would be the much greater number of difficult value judgements and messy classification overlaps that this would result in. While we chose the functional and sector classification schemes carefully to minimise these, even they were difficult and had a couple of instances where a tool was versatile enough to take on more than one possible function or sector. The other example typologies would be even worse, as many of the tools we reviewed could easily overlap across several spatial scales or a variety of different user groups, while classifying their methodologies and outputs would always require difficult simplifying generalisations in order to make them fit into defined categories.

[12] For example, if we added spatial scale as a third typology, and if we defined 'I / II / III / IV' for local, state, national and transboundary level, then we would have 36 overall tool categories, such as type 1-A-II.

Instead, we thus rely on our own qualitative observations and judgements to discuss this topic of niches and overlap, with this technique being adequate to note several interesting points from the various categories. Firstly, we can argue for an overabundance – or at least an adequate current number – of type 1-A tools. This is not simply because it contains the largest number of tools (50), since this category's more general nature should allow it more potential niches for tools than some of the other categories. That said, the 50 current tools seem to fill most of these niches adequately enough that significant amounts of overlap between them is now occurring. Within these 50, there are tools that cover all aspects of Hammill and Tanner's functional type 1, from communication tools (e.g. WWF's Climate Witness Community Toolkit) to risk screening and assessment tools (e.g. CRiSTAL, amongst many others), to implementation tools (e.g. UNDP's Designing Climate Change Adaptation Initiatives toolkit) and M&E tools (e.g. AdaptME). Likewise, these tools cover the range of potential audiences, from communities to local and national governments, to researchers, NGO workers and staff of multilateral organisations.

That said, the biggest strength – or weakness, in terms of tool overlap – of many of these type 1-A tools (and some 1-C tools too) is their versatility. Many present themselves as a comprehensive, start-to-finish guidebook, often beginning literally at the 'what is climate change' level and proceeding all the way through to adaptation option implementation and follow-up for their desired audience (e.g. USAID's Adapting to Coastal Climate Change guidebook). Inevitably, then, a significant amount of overlap exists between tools like these, especially since they are generally obtaining their own knowledge from the same sources: e.g. previous agreements on best practice in adaptation / risk management / climate communication / etc. from international fora like the UNFCCC and the IPCC. For example, the tools that focus on general community-based vulnerability and adaptation assessments (including CRiSTAL, CARE's Climate Vulnerability and Capacity Analysis and Community-Based Adaptation toolkits, Nakalevu (2006), FAO and IPG (2009), and ENDA and SEI (2013)) take quite similar approaches to these activities.[13] This is due to the fact that these tools have had to sacrifice specific contextual detail in order to be versatile across these many different community contexts. Likewise, while there are some tools designed for specific contexts (e.g. the BalticClimate toolkit), their layout, methods and outputs are usually quite similar to the more general tools, though they may introduce some unique regional data or cultural insights.

This highlights a more general problem facing many of these tools of both type 1 and 2, especially in developing countries: an inability to substantially diversify in their methods and recommendations, due to the continued uncertainty in predicting both local climate impact projections and existing microclimatic variability (i.e. the weather). At the local level, it is unlikely that this level of certainty will change any time soon. This is especially true for the water sector, as the projections on precipitation have generally been far less certain than the temperature projections (IPCC, 2007). Without perfect knowledge of the day-to-day variability and long-term impacts that will affect their audience of interest, these tools are thus forced to focus instead on general resilience building, 'no regrets' adaptation measures, flexible decision-making and all-encompassing risk management frameworks.[14] Of course, these are still useful practices – and indeed probably the best things to focus on developing further in our current environment of uncertainty – but could theoretically be summed up effectively in just a few focused tools, rather than the many that currently exist. In other words, we do not think it useful for any more of these types of tools to be developed until climate science advances to a point that they could credibly diversify to

[13] This is not to disparage their approach, which is a very useful one, but rather to just point out that more than one tool is discussing and recommending it.

[14] Anything beyond this could risk the aforementioned maladaptation from inappropriately selected interventions (Barnett and O'Neill, 2010).

focus on specific local or regional contexts, though this point may still be many years away. A potentially better use of developer time would be to focus on synthesising and harmonising some of the most similar groups of these tools, an activity which most of the previous tool reviews also recommend to various extents.

Beyond these issues, the other tool categories suffer less from overlap and could still benefit from additional new tools, though their fewer numbers inevitably support this as well. The type 1-B tools – with their focus on WASH best management – take a variety of different approaches, though similarly include many versatile, start-to-finish guidebooks, some of which inevitably overlap. Within the type 2 tools, there are quite a few very similar pieces of water modelling software, though they are somewhat diversified for different audiences through their complexity and price ranges. Nevertheless, more software of this type is unlikely to add much new value until or unless downscaled climate science substantially advances. Lastly, the few type 3 tools identified have a good diversity and could still benefit from many more new tools, such as more focused learning networks, more interactive knowledge sharing platforms like games, and more decision support 'meta-tools', as mentioned in Chapter 3. That said, two of the main web-based adaptation learning platforms that already exist – weADAPT and ALM – overlap quite substantially, so future ones would do well to specialise further or focus on different aspects of the topic.

Finally, we should note that this is not the first time that a discussion of this topic has been undertaken, with Hammill and Tanner (2011), GIZ (2009) and an older review by Tanner and Guenther (2007)[15] all notably discussing this issue of tool overlap. As highlighted in GIZ (p. 9), the risk of overlap is that of wasted resources and confused users, though the opposing argument is that 'tool development is a recent phenomenon and we should not kill its entrepreneurial spirit' by forbidding the development of new tools that may overlap with old ones, but perform better overall.[16] Reporting back from an early conference on tools, Tanner and Guenther found that overlap and replication was limited among the tools they considered, though their list only included a few of the most prominent tools at the time. Hammill and Tanner's more recent and broader review nevertheless still concurs with this, arguing that having many tools tailored to specific local needs is more desirable than having a few general tools. While we would agree with this goal, we disagree that this is what is currently happening, mainly because of our aforementioned argument that tools (at least the type 1-A category) have been prevented from being deeply tailored to specific local needs (even if they superficially claim to do so), due to the continued uncertainty in local climate impact projections.[17] As well, there are notably very few tools across all types that attempt to delve deeply into 'local context' beyond a climate lens – considering, for example, the political-economy of a specific city or country in its activities and recommendations. This is a major weakness, as building more favourable political / economic environments at the local level could contribute significantly to the aforementioned goal of building sectoral resilience to current climate variability.

[15] The results of this one were included in Hammill and Tanner's 2011 review, so it was not included as a 12th previous review here.

[16] We observe that the tool discourse lends itself well to the use of business-related terms. We will return to this entrepreneurship concept in the next section.

[17] In addition, Hammill and Tanner only reviewed 17 of the most well-known tools from our list, and those ones do indeed have a fair amount of diversity. The problems of overlap become more visible when undertaking a broader review like we did here, as the collection of the many less prominent tools helps better illustrate the extent of available niches within each category of tools before overlap begins occurring.

4.2 Oversupply and Lack of Demand?

This debate on whether the current supply of tools is overlapping or adequate can also be considered from another perspective: the users'. Whether or not we perceive there to be an abundance or lack of tools from the perspective of functionality and potential audiences, is anyone actually using them? This was discussed in some detail by Hammill and Tanner (2011), who surveyed various tool developers and users to conclude that many of the tools they reviewed were indeed 'top-down', developed world-driven processes (albeit with design collaboration at the local levels), with non-specialist development professionals as the intended users.

Hard evidence beyond this survey is scarce, though various tools provide hints. For example, the weADAPT website – which sells itself as one of the key practitioner loci for all things climate adaptation – does not appear to receive as much web traffic as a title like that might suggest. As of 22 July 2013, it has received only 137 'Likes' on its associated Facebook page, while its LinkedIn discussion group has only 18 members. Likewise, its YouTube channel has uploaded 17 public videos in the last five years, yet has received only two subscribers and a mere 1,492 views in total across all 17 of these videos. The ALM has done better, with a LinkedIn group containing 887 members, but a YouTube channel of similar status, with 21 public videos uploaded in the last two years, but only 16 subscribers and 4,785 total channel views. Admittedly, these are only proxy data for actual website hits, and we are well aware that many practitioners do not use these social media platforms – especially since they are not a core part of the tools, but merely supplementary content. Nevertheless, none of the figures are impressive enough to suggest that they have achieved strong global influence, since these same weak proxies for other things like organisations and influential people show much higher numbers (e.g. over 17,000 people have 'Liked' the Overseas Development Institute on Facebook, even though all of the content that we post there is available through our main website).[18]

We can take this further, onto some of the 'most popular' tools, such as IISD's CRiSTAL, which has likely been written about more heavily in the tools literature than any other CRM tool. On IISD's YouTube channel, they have uploaded two videos related to CRiSTAL (amongst others), with each having received only about 60 views (though they are both only a couple months old on the site).[19] The CRiSTAL website has also written up a number of case study reports of when the tool has been applied, of which there are 31, with some dating back as far as 2006. Even if we assume that only 25% of successful uses of the tool were documented in this fashion, the total number of uses – for one of the most popular CRM tools – would be only 124.

On the other hand, SEI's WEAP tool appears to have much more user engagement – perhaps simply because it is one of the few that openly displays its usage statistics. As mentioned earlier, its discussion forum currently contains 11,737 members from 171 countries. Likewise, in the last 12 months, its software has been downloaded 3,344 times and it gained 2,845 of its current members, with about 400 member visits to the site per month. This paints a picture of an impressively global and active tool, though this would not be determined if only looking at the two SEI YouTube videos that have been uploaded

[18] Links to the mentioned websites: **weADAPT**: Facebook (https://www.facebook.com/weadaptgroup) LinkedIn (http://www.linkedin.com/groups/weADAPTorg-User-Group-4419661/about), YouTube (http://www.youtube.com/user/seioxford?feature=watch);
ALM: LinkedIn (http://www.linkedin.com/groups?home=&gid=3322856&trk=anet_ug_hm), YouTube (http://www.youtube.com/user/AdaptationLearning)

[19] Older IISD videos on other subjects are not performing much better though, averaging around 300-400 views per video. IISD's YouTube channel: http://www.youtube.com/user/iisdvideo

about WEAP, which have both only received about 140 views in the last 10 months.[20] YouTube thus might not be a very useful proxy for measuring user engagement with tools, perhaps because most practitioners simply do not feel the need to watch YouTube videos to receive information on their tools of interest. Only the WEAP tool displays its other download and user statistics in such an open and transparent manner though, so it is unfortunately the only measure we have.

Nevertheless, aside from WEAP, possibly CRiSTAL, and a few others that have seen commercial success – such as the MIKE water management package by DHI – we have good reason to believe that a large majority of these tools have not sufficiently engaged their user communities or been used much at all, based on these types of website and social media hints. The first additional piece of evidence in support of this is the complete lack of active development and social media presence for most existing tools. Rather, we observe a large number of one-off reports or websites that are essentially just static publications. If these publications had generated a strong user interest and ongoing dialogue, this would likely be reflected in follow-up reports or other accompanying documentation, but this was rarely observed beyond the modelling software tools (which were more reliably updated).

One way to check this assertion more rigorously is to search the tools in Google Scholar, both for total search hits and for citations of the tool publication itself (applicable only when the tool consists of a single publication). This again does not appear to be a particularly useful proxy though, as it seems to underestimate popularity, probably because of the various challenges that likely arise for Google when trying to locate citations for each hit (e.g. if the citing author referenced the tool incorrectly, it might not appear in the citation list). For example, searching for "Water Evaluation and Planning System" (i.e. WEAP) – which we know to be popular because of its website statistics – returns only 441 total hits, with most of the top hits having been cited fewer than 10 times. Likewise, searching for CARE's "Climate Vulnerability and Capacity Analysis" tool – one that has received nearly as much attention as CRISTAL – returns only 109 total hits, and the actual publication itself has received only 16 citations.[21] Other single-publication tools fare worse, with UNEP's handbook on technologies for climate adaptation in the water sector receiving only two citations, while Heath et al.'s (2012) RCAA has apparently received zero citations. Again, while these search numbers may be underestimates, they nevertheless do not suggest a very high overall citation impact of these tools so far.

The second piece of potential evidence arises if we return to the entrepreneurship / 'tool industry' discourse. If tools were indeed operating in a competitive, demand-driven market environment, we would expect to find evidence of clear 'winners' and 'losers' much more readily, and probably fewer tools overall with much stronger niches. However, the market dynamics are shifted here, given the aforementioned evidence from Hammill and Tanner (2011) that many tools are donor-funded and developed world-driven. In this type of supply-driven market environment, donors are essentially funding the development of these tool products in advance of any user demand, hoping that their existence then stimulates demand. However, if user demand grew strong enough, then we could expect that many new tools would begin being developed by profit-seeking private sector actors, as the few tools that donors could afford to fund would not necessarily satisfy the variety of potential user demands. We do not observe this to be taking place, though, with most new (i.e.

[20] WEAP statistics: http://www.weap21.org/index.asp?action=116 , SEI YouTube: http://www.youtube.com/user/seivideos

[21] This tool was searched instead of CRiSTAL as it consists of a single publication, whereas CRiSTAL is described on its website and through a variety of case study publications. That said, it too helps illustrate the difficulty of Scholar as a proxy, since a full name search for CRiSTAL returned only 59 hits, whereas a search with the acronym returned 290,000 (unrelated to the tool itself, mainly relating to chemistry concepts and to an academic of the same surname).

2012/2013) tools still being created by donors, NGOs or academics. Indeed, across the entire list of 137, only nine tools have a 'private sector', profit-driven model of payment to access, six of which have been around since at least 2008.[22] This does not provide very strong evidence for any ongoing shift to a demand-driven user market.

This supply-driven market brings its own version of negative externalities as well. Firstly, in a demand-driven market, those 'failed' tools would be more clearly known as such, and likely discontinued due to lack of profit. In this supply-driven market, however, the cost of maintaining a 'failed' tool (once development is paid for) on an NGO's or donor's websites is essentially negligible, so the majority would persist, even if no one was using them. This leads to our present situation, where these tools and many more of the candidate tools we rejected here persist indefinitely on the internet, even if their methods and activities have long since been surpassed by better tools. Rather than promoting 'tool entrepreneurship', as was quoted earlier, this situation instead could promote confusion by users over which tool(s) are truly best-suited to their needs, since not everyone will have the available time needed to do in-depth research on 137+ potential CRM tools for their WASH services.[23]

Secondly, this supply-driven market could 'crowd out' potential private sector investment in tool development, which we believe is unfavourable. Donor funds are inevitably limited, which is illustrated in the many tools that remain 'static' after initial development. While a few donor-funded[24] tools like WEAP have managed to achieve a relatively stable state and low cost due both to the strong user support communities that they have developed[25] and to supplementary income sources,[26] this is clearly a rare model. It contrasts with fully 'private sector' tools like MIKE by DHI, whose revenues from tool sales can then be used for continual tool advancement and promotion, which then helps to build user demand and better advance toward the ultimate goal of promoting CRM more widely.

This is not a new discourse. The modern WASH discourse itself is very similar, moving away from 'input-focused' aid like latrine-building (after decades of this type of aid failing to significantly advance towards better WASH service coverage) towards a system where users are impelled to pay for their own WASH services, via techniques like community-led total sanitation and sanitation marketing. As described here, we believe that these lessons would work equally well for scaling-up this CRM tool industry.

4.3 Encouraging User-Centred Design

With these broader arguments in mind as one way to better promote user demand for tools, this final section will briefly discuss the issues around tool design as another way to promote better user engagement with individual tools. A good way to begin is by considering Garg et al.'s (2007, pp. 8-10) list of the 'qualities of a good tool'. The authors judge a tool depending on the extent to which it meets these qualities, which include:

- *Credibility*, in its analysis and judgements

[22] Note that 'payment for access' is not necessarily the only 'private sector' model that tools could take. Some private companies may choose to adopt a 'free, with advertising' model, or a variety of other business models, though this has not yet happened here. Also note that this figure should really read '9.5', as SEI's WEAP tool requires payment for some audiences (i.e. developed world users) but not others (i.e. developing world users).

[23] This, in turn, drives the production of the surprising number of tool reviews undertaken to date, including this one!

[24] Note that this term includes NGOs and academia, since they are also mainly funded by various donor sources.

[25] For example, users provide each other with technical support, suggest updates and undertake translation of the tool into other languages, all which lowers the salaried support staff requirements needed for SEI to maintain and grow the tool.

[26] As mentioned in footnote 21, SEI does charge access fees for developed world users, but remains free for developing world users.

- *Transparency*, in its assumptions and underlying mechanics
- *Acceptability to stakeholders*, designed with their advice and needs in mind
- *Relevance*, to policy and assessment objectives
- *Accuracy*, in its use of projections and available data
- *Measurability*, in its ability to quantify the outputs of its analysis
- *Reproducibility*, of its analysis
- *Comparability*, in its ability to assess different contexts in a similar way (when designed to do so)
- *Cost-effectiveness*, in balancing the detail and complexity of its assessment with the available resources
- *Flexibility to adapt and/or replicate*, across different contexts, while integrating the lessons from each assessment into the next one
- *Capability of identifying trends*, that could affect its analysis, both historical and future
- *Readily understood*, balancing complexity and simplicity of its user interface and underlying mechanics

While none of the tools reviewed here would likely score highly in every quality, they nonetheless serve as useful ideals for tool developers.

Prior to designing with this list in mind, though, developers would do well to first define – clearly and thoroughly – a statement of purpose for their tool, focusing on its specific function and audience, as well on how it adds new value to the existing landscape of tools.[27] This should go beyond the simple types of 1/2/3 and A/B/C, to also address those more 'difficult' typologies that we previously discussed: spatial scale, methodologies to use, audience to target, and outputs to generate, amongst others. The reason we could not easily classify these tools according to these various typologies is that many of them would not fit easily into firm categories within each. Many of these tools were either designed to be versatile across several contexts, but did not always sell themselves as such, or, conversely, were designed for a fairly specific context, but then attempted to sell themselves more widely. For example, many tools sold themselves as useful for local community members in developing countries, yet seemed to ignore a critical barrier to their uptake by making themselves available only in English. It is difficult for a tool to strive for the above-noted qualities of a good design if it is unable to even define itself, its purpose and its niche in a clear and specific manner.

After this is accomplished, developers then face some difficult operational trade-offs in their attempt to strive for the above-noted qualities. For example, the appropriate balancing of the complexity and simplicity of a tool's user interface can be extremely challenging, and is a key factor for generating user engagement. A simpler interface can decrease the need for user training – and thus facilitate the scale-up of tool usage – but may result in the trade-off of weaker analysis when compared to a more complex interface. Another difficult design trade-off can occur in the decision to make the tool implementation – or indeed the process of choosing the appropriate tool(s) itself – an 'expert'-led or self-assessment exercise. Depending on the audience's trust in the expert facilitator, the former could result in either better or worse outputs as compared with a self-assessment exercise. That said though, the latter risks producing inaccurate, incomparable or irreproducible results, due to the lack of expert guidance from the facilitator. The former would generally cost more as

[27] That said, design, intent and transparency may not always be necessary for some applications. Ultimately, good results are the objective, and end users may often be resourceful enough to make good use of a superficially 'inappropriate' tool (e.g. someone who uses a book to hammer a nail into wood – while the book was not designed to be a hammer, it can serve as one by an opportunistic user).

well, again limiting tool scale-up. These are just a couple examples of the difficult decisions facing the development of ‘good enough’ versus ‘not good enough’ tools.

4.4 Summary

This chapter discussed three key lessons learned from this tool review: 1) the degree to which the various tools overlapped and whether the amount of tools was appropriate, 2) the degree to which evidence exists of active user demand for these tools, and what broad strategies could better promote it, and 3) the degree to which issues of individual tool design, and the various trade-offs faced in their design choices, could affect and better promote this user engagement and demand.

The first lesson emphasised that several of the tool types could still benefit from further tool development, while others, notably type 1-A tools, were suffering from fairly high degrees of overlap. This is due mainly to the difficulty in defining future climate conditions with adequate precision and accuracy, a condition which is unlikely to change in the near future.

The second lesson highlighted that – with some notable exceptions – there generally does not appear to be much user demand for many of these tools and that the ‘tool industry’ is predominantly supply-driven. To help address this, we recommended the promotion of a more favourable private sector discourse, along the lines of the one that already exists elsewhere in the WASH sector, to help shift the market to one that is driven by user demand. Encouraging the private sector to promote this user demand and willingness to pay for these tools would generate revenue for more tool maintenance and ongoing support that donors and NGOs to date have largely been unable to provide, which could help to scale up their use.

The third lesson then discussed some ideal qualities of a ‘good’ tool, but underscored the difficult design trade-offs that often block their achievement. We also emphasised the need for developers to think first and foremost about a clear and specific purpose, function, audience and niche for their tool, which would help avoid many of the most grievous design follies.

These are a few, but by no means all, of the lessons that this broad review of ours gave us. While many of them are echoed by previous tool reviews, there are also some points of departure here, especially for our views on the degree of tool overlap and user engagement. Above all though, we believe that the most important point of this chapter was to argue for a shift in this tool industry away from a supply-driven market toward a demand-driven one. This could be done by changing the incentives to stimulate greater private sector engagement, which would subsequently stimulate greater user interest in applying these tools and in gaining a better understanding of the key principles of good climate risk management for the WASH sector.

5 Policy Recommendations for Tool Users and Developers

This very brief chapter aims to condense our lessons learned from this review into some short and practical guidance for tool users and developers. These recommendations should also provide useful insight to other stakeholders, especially for donor staff and researchers who support this tool industry.

5.1 Recommendations for Tool Users

- **As a first step, think carefully about your specific needs from a tool – and indeed whether you need a tool at all**
  - Try to first carefully define your problem, its climate-relevance, and the ideal solutions you seek before beginning to search for tools at all, to avoid being influenced by individual 'sales pitches' of tools you review
  - Consider not just your functional needs related to climate risk management and WASH, but also your personal needs related to the tool design itself. For example, do you prefer an expert-led or self-assessment tool, a one-off or ongoing tool, a simple and less detailed or complex and more detailed tool, etc.
  - You might not always need a tool to tackle your specific functional needs – you may be better served by many other forms of support, such as reading relevant research literature, seeking guidance from a mentor, etc.
- **Once you decide on your need for a tool, learn about as many of them as possible, through research and expert guidance, before choosing any**
  - Minimise your research time by first relying on existing tool reviews, expert guidance and decision support 'meta tools', whenever available
  - Also try to consult with similar existing tool users wherever possible, to gain their insights from using tools in their own contexts
- **To help you make a decision on the most suitable tool(s) for your needs, try to assess them based on the 12 qualities of a good tool: *credibility, transparency, acceptability to your stakeholders, relevance, accuracy, measurability, reproducibility, comparability, cost-effectiveness, flexibility to adapt and replicate, capability to identify trends,* and *comprehensibility.***
  - Key things to watch out for include, amongst others: the tool's working language, whether you would require training or facilitation to use it, its price, and whether user support is easily available
- **Remember that no single tool is 'perfect' and that you may require several, working in parallel or in sequence, to fulfil your needs**

5.2 Recommendations for Tool Developers

- **As a first step before starting to develop a new tool, think carefully about what new and unique niche it would fill – and indeed whether the market really needs this new tool at all**
  - Try to structure and categorise your idea as much as possible by considering the function you would like it to have, the sector you would like it to operate in, the audience you would like it to reach, the spatial scale you would like it to operate on, and the methods and outputs you would like it to use and generate
  - Also try drafting organisational-style 'vision' and 'mission' statements of purpose for your idea, to help further define how it could add new value
  - Consult existing tool reviews and other tool experts, to help you locate categories of relative tool abundance or scarcity
  - 'New tool or no tool' are not necessarily your only two options: many existing tools would benefit greatly from modification to promote better inter-tool harmonisation or to combine several tools into fewer, more sophisticated ones
  - Also consider your funding situation carefully: who will pay for your tool's initial development and – more importantly – its subsequent operation and maintenance costs? If you intend to charge a fee for the use of your tool, how will you effectively compete with 'free' tools?
- **Once you have decided on the need for your tool, learn about as many other tools as possible, through research and expert guidance, before finalising any design and promotion elements of your own tool**
  - In particular, assess how other successful tools balanced the trade-offs inherent in the various tool design decisions related to the 12 qualities of a good tool (as outlined in the tool user recommendations)
  - Key things to consider in your design include, amongst others: the tool's working language in relation to its desired audience, the tool's use (or not) of an expert facilitator or trainer, and the tool's desired balanced between simplicity and complexity of its user interface
  - Regardless of your funding situation, devote at least equal attention to the promotion and marketing campaign for your eventual tool: how will you ensure that it reaches its audiences and stimulates their demand to use it or pay for it? You may want to seek advice from successful advertising agencies or existing tool developers
- **Remember that your tool can never be 'perfect' for everyone: your tool is more likely to have a lasting impact if it can excel in a specific, unique niche, rather than attempting to be a weaker and more common 'generalist'**

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6.1 Main Text

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Annex 1: Detailed List of Tools Reviewed

Tool Name	Developer / Author	Type(s) (1/2/3 – A/B/C)[28]	Reference Link[29] *(Previous Reviews of the Tool)*
Adaptation Database and Planning Tool (ADAPT)	International Council for Local Environmental Initiatives - Local Governments for Sustainability (ICLEI) USA	1 - A	ICLEI (2013) http://www.icleiusa.org/tools/adapt
Adaptation Policy Framework for Climate Change (APF)	UNDP	1 - A	UNDP (2003) http://www.eird.org/cd/on-better-terms/docs/UNDP-GEFUsers-Guide-to-the-Adaptation-Policy-Framework.pdf *(Reviewed by Olhoff and Schaer (2010), Hammill and Tanner (2011), UNFCCC (2008) and CCCCC (2013))*
Adaptation Screening Matrix and Adaptation Decision Matrix	Stratus Consulting	1 - A	Stratus (2013) http://stratusconsulting.com/services/climate/assessing-vulnerability-

[28] We attempt to classify tools using both functional and sectoral classification, based on our own best judgement, where 1/2/3 represents the three functional types of Figure 1 and where A/B/C represents the three sector types represented in Figure 2.

[29] Note that all URLs were current at the time of writing (July 2013), but will inevitably change with time. Citations are thus also provided to the full references in Chapter 7. Only tools with active URLs were included.

			and-adaptation/ *(Reviewed by Garg et al. (2007) and UNFCCC (2008))*
Adaptation to Coastal Climate Change: a Guidebook for Development Planners	USAID	1 - A	USAID (2009) http://pdf.usaid.gov/pdf_docs/pnado614.pdf *(Reviewed by GIZ (2009), Hammill and Tanner (2011), ALM (2013) and CCCCC (2013))*
Adaptation toolkit – Guidebook for researchers and adaptation practitioners working with local communities	Energie, Environnement, Developpement (ENDA) & SEI	1 - A	Ampomah and Devisscher (2013) http://static.weadapt.org/knowledge-base/files/1128/51d4187011529adaptation-toolkit-march-2013.pdf *(Reviewed by CCCCC (2013) and weADAPT (2013))*
Adaptation toolkit: sea-level rise and coastal land use – how governments can use land-use practices to adapt to sea-level rise	Georgetown Climate Centre	1 - A	Grannis (2011) http://www.georgetownclimate.org/sites/default/files/Adaptation_Tool_Kit_SLR.pdf *(Reviewed by CCCCC (2013))*
Adaptation Wizard	UK Climate Impacts Programme (UKCIP)	1 - A	UKCIP (2013c) http://www.ukcip.org.uk/wizard/ *(Reviewed by Olhoff and Schaer (2010), Hammill and Tanner (2011), Traerup and Olhoff (2011), UNFCCC (2008) and weADAPT (2013))*
Adapting to climate change: a planning guide for state coastal managers	National Oceanic and Atmospheric Administration (NOAA) Office of Ocean and Coastal Resource Management	1 - A	NOAA (2010) http://coastalmanagement.noaa.gov/climate/docs/adaptationguide.pdf *(Reviewed by CCCCC (2013))*
Adapting to climate variability and change: A guidance manual for development planning	USAID	1 - A	USAID (2007) http://pdf.usaid.gov/pdf_docs/PNADJ990.pdf *(Reviewed by Olhoff and Schaer (2010), Hammill and Tanner, (2011), weADAPT (2013), ALM (2013) and CCCCC (2013))*
AdaptME (Monitoring and Evaluation)	UKCIP	1 - A	UKCIP (2013d) http://www.ukcip.org.uk/adaptme-toolkit/
Applying climate information for adaptation decision-making	UNDP, UNEP and the Global Environment Facility (GEF) National Communications	1 - A	Lu (2008) http://www.adaptationlearning.net/sites/default/files/ncsp.pdf *(Reviewed by ALM (2013))*

	Support Programme		
BalticClimate Toolkit	EU Baltic Sea Region Programme	1 - A	EU (2012) http://www.toolkit.balticclimate.org/index.php *(Reviewed by weADAPT (2013))*
Business Area Climate Impacts Assessment Tool (BACLIAT)	UKCIP	1 - A	UKCIP (2013a) http://www.ukcip.org.uk/bacliat/ *(Reviewed by UNFCCC (2008) and weADAPT (2013))*
Caribbean risk management guidelines for climate change adaptation decision making	The Caribbean Community (CARICOM)	1 - A	CARICOM (2003) http://200.32.211.67/M-Files/openfile.aspx?objecttype=0&docid=2879 *(Reviewed by CCCCC (2013))*
CEDRIG – Climate, Environment and Disaster Risk Reduction Integration Guidance	Swiss Agency for Development and Cooperation (SDC)	1 - A	SDC (2012) http://www.sdc-drr.net/cedrig *(Reviewed by CCCCC (2013))*
CLARA – Climate Adaptation Resource for Advisors	UKCIP	1 - A	UKCIP (2013b) http://www.ukcip.org.uk/clara/
Climate Change and Environmental Degradation Risk and Adaptation Assessment (CEDRA)	Tearfund	1 - A	Tearfund (2012) http://tilz.tearfund.org/Topics/Environmental+Sustainability/CEDRA.htm *(Reviewed by GIZ (2009), Hammill and Tanner (2011), Traerup and Olhoff (2011), CCCCC (2013) and weADAPT (2013))*
Climate Check	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)	1 - A	Kropp and Scholze (2009) http://www2.gtz.de/dokumente/bib-2009/gtz2009-0175en-climate-change-information.pdf *(Reviewed by GIZ (2009), OECD (2009) and Hammill and Tanner, (2011))*
Climate Guide	Red Cross / Red Crescent	1 - A	Red Cross/Red Crescent (2007) http://www.climatecentre.org/downloads/File/reports/RCRC_climateguide.pdf *(Reviewed by Olhoff and Schaer (2010) and Hammill and Tanner (2011))*

Climate Proofing for Development	GIZ	1 - A	Hahn and Frode (2011) http://www.preventionweb.net/files/globalplatform/entry_bg_paper~giz2011climateproofing.pdf *(Reviewed by Hammill and Tanner (2011), Traerup and Olhoff (2011) and CCCCC (2013))*
Climate proofing: A risk-based approach to adaptation	ADB	1 - A	ADB (2005) http://www.adb.org/sites/default/files/pub/2005/climate-proofing.pdf *(Reviewed by CCCCC (2013))*
Climate Vulnerability and Capacity Analysis (CVCA)	CARE	1 - A	CARE (2009) http://www.careclimatechange.org/cvca/CARE_CVCAHandbook.pdf *(Reviewed by Hammill and Tanner (2011), Traerup and Olhoff (2011), ALM (2013), weADAPT (2013), and CCCCC (2013))*
Climate Witness community toolkit for the South Pacific	World Wide Fund for Nature (WWF)	1 - A	WWF (2009) http://assets.panda.org/downloads/cw_toolkit.pdf *(Reviewed by Hammill and Tanner (2011))*
Climate-resilient cities: a primer on reducing vulnerabilities to climate change impacts and strengthening disaster risk management in East Asian cities	The World Bank	1 - A	Prasad et al. (2008) http://documents.worldbank.org/curated/en/2008/06/9740566/climate-resilient-cities-primer-reducing-vulnerabilities-climate-change-impacts-strengthening-disaster-risk-management-east-asian-cities *(Reviewed by ALM (2013))*
Community-Based Risk Screening Tool – Adaptation and Livelihoods (CRiSTAL)	International Institute for Sustainable Development (IISD), et al.	1 - A	IISD et al. (2013) http://www.iisd.org/cristaltool/ *(Reviewed by GIZ (2009), OECD (2009), Olhoff and Schaer (2010), Hammill and Tanner (2011), Traerup and Olhoff (2011), UNFCCC (2008), weADAPT (2013), ALM (2013) and CCCCC (2013))*
Comprehensive Hazard and Risk Management (CHARM)	Applied Geoscience and Technology Division – Secretariat of the Pacific Community (SOPAC)	1 - A	SOPAC (2001) http://ict.sopac.org/VirLib/DM0044.pdf *(Reviewed by UNFCCC (2008) and CCCCC (2013))*
CV&A: a guide to community vulnerability and adaptation assessment and action	Secretariat of the Pacific Regional Environment Programme (SPREP)	1 - A	Nakalevu (2006) http://www.sprep.org/att/publication/000437_cvaguidee.pdf *(Reviewed by ALM (2013))*

Designing Climate Change Adaptation Initiatives: A UNDP Toolkit for Practitioners	UNDP	1 - A	UNDP (2010) http://www.undp.org/content/dam/aplaws/publication/en/publications/environment-energy/www-ee-library/environmental-finance/low-emission-climate-resilient-development/designing-adaptation-initiatives-toolkit/Toolkit%20FINAL%20(new%20cover).pdf *(Reviewed by Hammill and Tanner (2011), Traerup and Olhoff (2011), weADAPT (2013), CCCCC (2013) and ALM (2013))*
Guidelines for developing a coastal risk management plan	Government of Tasmania – Department of Primary Industries and Water	1 - A	Government of Tasmania (2009) http://www.dpiw.tas.gov.au/inter.nsf/Attachments/KCRE-7PE8CC/$FILE/CRMP_Template_and_Guidelines.pdf *(Reviewed by CCCCC (2013))*
ICLEI-ACCCRN urban climate change resilience toolkit	ICLEI and the Asian Cities Climate Change Resilience Network (ACCCRN)	1 - A	ICLEI and ACCCRN (2013) http://www.teriin.org/events/Sunandan-Tiwari.pdf http://www.scribd.com/doc/144824994/ACCCRN-ICLEI-Replication-Press-Release
Identifying Adaptation Options (AdOpt)	UKCIP	1 - A	UKCIP (2012) http://www.ukcip.org.uk/adopt/ *(Reviewed by UNFCCC (2008))*
Integrating Climate Change Adaptation into Secure Livelihoods Toolkits	Christian Aid	1 - A	Christian Aid (2010) http://www.adaptationlearning.net/sites/default/files/Adaptation%20toolkit%201.pdf http://www.adaptationlearning.net/sites/default/files/Adaptation%20toolkit%202.pdf *(Reviewed by Hammill and Tanner (2011), ALM (2013) and CCCCC (2013))*
Local government climate change adaptation toolkit	ICLEI Oceania	1 - A	ICLEI (2008) http://archive.iclei.org/index.php?id=adaptation-toolkit0 *(Reviewed by ALM (2013))*
Mainstreaming climate change adaptation into development planning: a guide for practitioners	UNDP – UNEP Poverty Environment Initiative	1 - A	UNDP and UNEP (2011) http://www.unep.org/pdf/mainstreaming-cc-adaptation-web.pdf
Mainstreaming Climate Change	CARE International in Vietnam	1 - A	Huxtable and Nguyen (2009)

Adaptation: a Practitioner's Handbook			http://www.careclimatechange.org/files/adaptation/CARE_VN_Mainstreaming_Handbook.pdf *(Reviewed by CCCCC (2013))*
Methodology guide for the assessment of total climate risk and resilience measures	Economics of Climate Adaptation Working Group	1 - A	ECA (2009) http://ec.europa.eu/development/icenter/repository/ECA_Shaping_Climate_Resilent_Development.pdf *(Reviewed by CCCCC (2013))*
OECD 'Climate Lens' Guidance on Integrating Climate Change Adaptation into Development Projects	Organisation for Economic Co-operation and Development (OECD)	1 - A	OECD (2009) http://www.oecd.org/dac/43652123.pdf *(Reviewed by Olhoff and Schaer (2010) and Hammill and Tanner (2011))*
Opportunities and Risks of Climate Change and Disasters (ORCHID) & Climate Risk Impacts on Sectors and Programmes (CRISP)	DFID and Institute for Development Studies (IDS), UK	1 - A	(ORCHID - Multiple publications) http://www.ids.ac.uk/climatechange/orchid CRISP – Downing et al. (2008) http://www.dewpoint.org.uk/Asset%20Library/DFID/Climate%20Risk%20Assessment%20Report%20-%20Kenya.pdf Tanner et al. (2008) http://www.ids.ac.uk/files/dmfile/CHinaCLimateSCreeningSynthesisEnglish.pdf *(Reviewed by GIZ (2009), OECD (2009), Olhoff and Schaer (2010), Hammill and Tanner (2011), Traerup and Olhoff (2011), weADAPT (2013) and CCCCC (2013))*
PACT: helping companies assess their strategic exposure to climate risks	Alexander Ballard Ltd.	1 - A	Alexander Ballard (2013) http://alexanderballard.co.uk/pact/ *(Reviewed by weADAPT (2013))*
Participatory tool on climate and disaster risks[30]	Swiss Interchurch Aid (HEKS) and Bread for All	1 - A	HEKS and Bread for All (2010) http://www.adaptationlearning.net/sites/default/files/CliDR%20Eng_Vers5_0.pdf *(Reviewed by ALM (2013))*

[30] Note that this tool is based largely on CRiSTAL & CARE's CVCA

Planning for Community-Based Adaptation to Climate Change	Food and Agricultural Organisation (FAO) and the Department of Physical Geography at University of Freiburg (IPG)	1 - A	FAO and IPG (2009) http://www.webgeo.de/fao-webgeo-2-intro/ *(Reviewed by GIZ (2009) and ALM (2013))*
Preparing for Climate Change: A Guidebook for Local, Regional and State Governments	Center for Science in the Earth System (The Climate Impacts Group) (CIG) et al.	1 - A	CIG et al. (2007) http://www.cses.washington.edu/db/pdf/snoveretalgb574.pdf
Strategic environmental assessment and adaptation to climate change guidebook	OECD	1 - A	OECD (2008) http://www.oecd.org/environment/environment-development/42025733.pdf *(Reviewed by Olhoff and Schaer (2010))*
The guidance tool: a manual for mainstreaming climate change adaptation into the comprehensive disaster management framework country work programme	The Caribbean Disaster Emergency Management Agency (CDEMA)	1 - A	CDEMA (2011) http://unfccc.int/files/adaptation/application/pdf/cca_guidance_tool_e_book_.pdf *(Reviewed by CCCCC (2013))*
Toolkit for Community-based Adaptation	CARE	1 - A	CARE (2010a) http://www.careclimatechange.org/files/toolkit/CARE_CBA_Toolkit.pdf *(Reviewed by Hammill and Tanner (2011) and ALM (2013))*
Toolkit for Integrating Adaptation into Development Projects	CARE	1 - A	CARE (2010b) http://www.careclimatechange.org/files/toolkit/CARE_Integration_Toolkit.pdf *(Reviewed by Hammill and Tanner (2011) and CCCCC (2013))*
Urban risk assessments: understanding disaster and climate risk in cities	The World Bank	1 - A	Dickson et al. (2012) http://documents.worldbank.org/curated/en/2012/06/16499064/urban-risk-assessments-understanding-disaster-climate-risk-cities *(Reviewed by CCCCC (2013))*
Vulnerability and capacity assessment methodology: a guidance manual for the conduct and mainstreaming of climate	CCCCC	1 - A	Pulwarty and Hutchinson (2008) http://dms.caribbeanclimate.bz/M-Files/openfile.aspx?objtype=0&docid=2756 *(Reviewed by CCCCC (2013))*

change vulnerability and capacity assessments in the Caribbean			
Vulnerability and capacity assessment training and toolbox	International Federation of Red Cross and Red Crescent Societies (IFRC)	1 - A	IFRC (various) http://www.ifrc.org/en/what-we-do/disaster-management/preparing-for-disaster/disaster-preparedness-tools/disaster-preparedness-tools/ *(Reviewed by CCCCC (2013))*
Vulnerability Reduction Assessment (VRA) tool	UNDP	1 - A	UNDP (2008) http://www.seachangecop.org/files/documents/2008_12_CBA_Vulnerability_Reducation_Assessment_Guide.pdf http://www.adaptationlearning.net/sites/default/files/ALM-contribution-VRA-communities-2011.pdf *(Reviewed by ALM (2013))*
10-Step Promotion Program Toolkit for WASH	USAID WaterLinks	1 - B	WaterLinks (2013) http://www.10step-toolkit.org/
A Guide to the Development of on-Site Sanitation	WHO	1 - B	WHO (1992) http://www.who.int/water_sanitation_health/hygiene/envsan/onsitesan.pdf *(Reviewed by Palaniappan et al. (2008))*
ASPIRE – A Sustainability, Poverty and Infrastructure Routine for Evaluation	Arup International Development / Engineers Against Poverty	1 - B	ASPIRE (2013) http://www.oasys-software.com/products/environmental/aspire.html
Community-based disaster risk management: field practitioner's handbook	Asian Disaster Preparedness Centre (ADPC)	1 - B	Abarquez and Murshed (2004) http://www.adpc.net/pdr-sea/publications/12Handbk.pdf
Community-Based Water Resiliency Tool (CBWR)	US Environmental Protection Agency (US EPA)	1 - B	US EPA (2011) http://water.epa.gov/infrastructure/watersecurity/techtools/cbwr.cfm
DFID Guidance Manual on Water Supply and Sanitation Programmes	Water and Environmental Health at London and Loughborough (WELL) and DFID	1 - B	WELL and DFID (1998) http://www.lboro.ac.uk/well/resources/Publications/guidance-manual/guidance-manual.htm *(Reviewed by Palaniappan et al. (2008))*

From source to tap: guidance on the multi-barrier approach to safe drinking water	Canadian Council of Ministers of the Environment (CCME)	1 - B	CCME (2004) http://www.ccme.ca/assets/pdf/mba_guidance_doc_e.pdf *(Reviewed by Palaniappan et al. (2008))*
Guidelines on Municipal Wastewater Management	UNEP et al.	1 - B	UNEP (2004) http://esa.un.org/iys/docs/san_lib_docs/guidelines_on_municipal_wastewater_english.pdf *(Reviewed by Palaniappan et al. (2008))*
Improving partnership governance in water services through public-private partnerships (PPPs) toolkit	Building Partnerships for Development (BPD)	1 - B	BPD (2011) http://www.partnershipsforwater.net/web/w/www_7_en.aspx *(Reviewed by Palaniappan et al. (2008))*
Just Stir Gently: The Way to Mix Hygiene Education with Water Supply and Sanitation	IRC International Water and Sanitation Centre	1 - B	Boot (1991) http://docs.watsan.net/Scanned_PDF_Files/Class_Code_2_Water/203.2-91JU-8660.pdf *(Reviewed by Palaniappan et al. (2008))*
Linking Technology Choice with Operation and Maintenance in the Context of Community Water Supply and Sanitation	WHO & IRC	1 - B	Brikke and Bredero (2003) http://whqlibdoc.who.int/publications/2003/9241562153.pdf *(Reviewed by Palaniappan et al. (2008))*
Management Guide: Series of Manuals on Drinking Water Supply	Swiss Resource Centre and Consultancies for Development (SKAT)	1 - B	Frohlich (2001) http://www.rural-water-supply.net/_ressources/documents/default/1_Management-Guide.pdf *(Reviewed by Palaniappan et al. (2008))*
MIKE by DHI software (*various*)	DHI Group	1 - B 1 - C 2 - B 2 - C	DHI Group (2013) http://mikebydhi.com/ *(Reviewed by Garg et al. (2007) and UNFCCC (2008))*
Natural disaster mitigation in drinking water and sewerage systems: Guidelines for vulnerability analysis	Pan American Health Organisation (PAHO)	1 - B	PAHO (1998) http://www1.paho.org/English/Ped/nd-water_mit.pdf *(Reviewed by UNFCCC (2008))*
Safe Water Guide for the Australian	Australian Agency for	1 - B	AusAid (2005)

Aid Program 2005	International Development (AusAid)		http://www.wsportal.org/uploads/IWA%20Toolboxes/WSP/safe_water_guide.pdf *(Reviewed by Palaniappan et al. (2008))*
Sanitation and Hygiene Promotion – Programming Guidance	Water Supply and Sanitation Collaborative Council (WSSCC) and WHO	1 - B	WSSCC and WHO (2005) http://www.who.int/water_sanitation_health/hygiene/sanhygpromo.pdf *(Reviewed by Palaniappan et al. (2008))*
Sanitation safety planning	WHO and the International Water Association (IWA)	1 - B	WHO (2010) http://www.who.int/water_sanitation_health/wastewater/sanitation_safety_plans_Concept_NoteV11_4_2_17_092010.pdf
Service Delivery Approach for rural water supply	Harold Lockwood and Stef Smits	1 - B	Lockwood and Smits (2011) http://www.waterservicesthatlast.org/publications/multi_country_synthesis
Sustainable Community Management of Urban Water and Sanitation Schemes (A Training Manual)	Water and Sanitation Programme of the World Bank (WSP-WB) and DAWASA	1 - B	Castro et al. (2009) http://www.wsp.org/sites/wsp.org/files/publications/africa_training_manual.pdf
Sustainable Wastewater Management: a Handbook for Smaller Communities	Ministry for the Environment (MFE), New Zealand	1 - B	MFE (2003) http://www.mfe.govt.nz/publications/waste/wastewater-mgmt-jun03/# *(Reviewed by Palaniappan et al. (2008))*
The GEMI Local Water Tool	Global Environmental Management Initiative (GEMI) & the World Business Council for Sustainable Development (WBCSD)	1 - B	WBCSD (2013) http://www.wbcsd.org/work-program/sector-projects/water/localwatertool.aspx
The International Benchmarking Network (IBNET) for Water and Sanitation Utilities – Toolkit	IBNET	1 - B	IBNET (2011) http://www.ib-net.org/ *(Reviewed by Palaniappan et al. (2008))*
The Manager's Non-Revenue Water Handbook: a Guide to Understanding Water Losses	Ranhill Utilities Berhad and USAID	1 - B	Farley et al. (2008) http://www.waterlinks.org/sites/default/files/NRW%20Manager's%20Handbook.pdf

The WBCSD Global Water Tool	WBCSD	1 - B	WBCSD (2012) http://www.wbcsd.org/work-program/sector-projects/water/global-water-tool.aspx
The WRC Community-Based Health and Hygiene Model and Implementation Kit	South African Water Research Commission (WRC)	1 - B	Onabolu and Ndlovu (2006) http://www.wrc.org.za/Knowledge%20Hub%20Documents/Research%20Reports/TT264-06.pdf *(Reviewed by Palaniappan et al. (2008))*
Tools for mainstreaming disaster risk reduction	IFRC and the ProVention Consortium	1 - B	Benson and Twigg (2007) http://www.preventionweb.net/files/1066_toolsformainstreamingDRR.pdf *(Reviewed by Olhoff and Schaer (2010), Traerup and Olhoff (2011), weADAPT (2013) and CCCCC (2013))*
Towards Better Programming: a Manual on Hygiene Promotion	UNICEF and the London School of Hygiene and Tropical Medicine (LSHTM)	1 - B	UNICEF and LSHTM (1999) http://www.unicef.org/wash/files/hman.pdf *(Reviewed by Palaniappan et al. (2008))*
Towards Better Programming: a Sanitation Handbook	UNICEF and USAID	1 - B	UNICEF and USAID (1997) http://www.unicef.org/wash/files/San_e.pdf *(Reviewed by Palaniappan et al. (2008))*
Towards Better Programming: a Water Handbook	UNICEF	1 - B	UNICEF (1999) http://www.unicef.org/wash/files/Wat_e.pdf *(Reviewed by Palaniappan et al. (2008))*
Urban Water Supply and Sanitation Programming Guide	Planning and Development Collaborative International (PADCO) and USAID	1 - B	PADCO (2001) http://www.watersanitationhygiene.org/References/EH_KEY_REFERENCES/WATER/Urban%20Water/Urban%20WatSan%20Guide%20(USAID).pdf *(Reviewed by Palaniappan et al. (2008))*
Urban Water Supply Handbook	Larry W. Mays	1 - B	Mays (2002) http://www.amazon.co.uk/Supply-Handbook-McGraw-Hill-Handbooks-ebook/dp/B000TL2Z6W *(Reviewed by Palaniappan et al. (2008))*
Vulnerability Self-Assessment Tool	US EPA	1 - B	US EPA (2010)

(VSAT)			http://water.epa.gov/infrastructure/watersecurity/techtools/vsat.cfm *(Reviewed by Garg et al. (2007)*
WASH technology information packages	UNICEF	1 - B	Baumann et al. (2010) http://www.rural-water-supply.net/_ressources/documents/default/1-471-2-1359464901.pdf
Water and Sanitation for All: a Practitioner's Companion	WSP-WB and Water Utility Partnership (WUP) – Africa	1 - B	WSP-WB and WUP (2003) http://web.mit.edu/urbanupgrading/waterandsanitation/home.html *(Reviewed by Palaniappan et al. (2008))*
Water and sanitation PPP toolkits	The World Bank	1 - B	The World Bank (2011) http://ppp.worldbank.org/public-private-partnership/sector/water-sanitation/toolkits *(Reviewed by Palaniappan et al. (2008))*
Water Health and Economic Analysis Tool (WHEAT)	US EPA	1 - B	US EPA (2012b) http://water.epa.gov/infrastructure/watersecurity/techtools/wheat.cfm
Water Operator Partnership Facilitation Guidelines	USAID and WaterLinks	1 - B	WaterLinks (2011) http://www.waterlinks.org/sites/default/files/WOP%20Content%20FINAL.pdf
Water safety planning	Various (originally the WHO)	1 - B 3 - B	Examples include: Bartram et al. (2009) http://whqlibdoc.who.int/publications/2009/9789241562638_eng.pdf WHO WPRO (2008) http://www.wpro.who.int/publications/docs/TrainingWorkbookonWSPforUrbanSystems.pdf Greaves and Simmons (2011) http://tilz.tearfund.org/webdocs/Tilz/Topics/watsan/Water%20Safety%20Plans/WSP%20for%20communities%20-%20main%20text.pdf WHO (2006) http://www.who.int/wsportal/en/ *(Reviewed by Palaniappan et al. (2008))*
Adaptation Tipping Points approach	Deltares	1 - C	Kwadijk et al. (2010) www.deltares.nl/xmlpages/TXP/files?p_file_id=14123

AdaptWater	Water Services Association of Australia (WSAA) et al.	1 - C	WSAA (2013) https://www.wsaa.asn.au/WSAAPublications/Corporate/AdaptWater%20Final%20Report.pdf https://www.wsaa.asn.au/WSAAPublications/FactSheets/AdaptWater%20Fact%20Sheet.pdf
Assessing Future Uncertainties Associated with Urban Drainage using Flexible Systems – the COFAS Method and Tool	SWITCH Project – UN Educational, Scientific and Cultural Organisation (UNESCO) Institute for Water Education (IHE)	1 - C	Peters et al. (2010) http://www.switchurbanwater.eu/outputs/pdfs/W2-1_GEN_MAN_D2.1.4_Assessing_future_uncertainties_urban_drainage_COFAS.pdf
Assessing the Robustness of Adaptation Decisions to Climate Change Uncertainties: a Case Study on Water Resources Management in the East of England	Suraje Dessai and Mike Hulme	1 - C	Dessai and Hulme (2007) http://www.sciencedirect.com/science/article/pii/S0959378006000914
Climate Finance Impact Tool (FIT) for Adaptation	Japan International Cooperation Agency (JICA)	1 - C	JICA (2011) http://www.jica.go.jp/english/our_work/climate_change/pdf/adaptation_all.pdf
Climate Resilience Evaluation and Awareness Tool (CREAT)	US EPA	1 - C	US EPA (2012a) http://water.epa.gov/infrastructure/watersecurity/climate/creat.cfm *(Reviewed by ALM (2013))*
Climate safeguards system: climate screening and adaptation review and evaluation procedures booklet	African Development Bank (AfDB)	1 - C	AfDB (2011) http://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/CSS%20Basics-En_def.pdf *(Reviewed by weADAPT (2013) and CCCCC (2013))*
Examining climate risk using a modified uncertainty matrix framework for the water sector	Marie Ekström et al.	1 - C	Ekström et al. (2012) http://www.sciencedirect.com/science/article/pii/S0959378012001343
Guidance on Water and Adaptation to Climate Change	UN Economic Commission for Europe (UNECE): Convention on the Protection and Use of Transboundary Watercourses	1 - C	UNECE (2009) http://www.unece.org/fileadmin/DAM/env/water/publications/documents/Guidance_water_climate.pdf

	and International Lakes		
Guidance on water supply and sanitation in extreme weather events	UNECE and WHO Europe	1 - C	Sinisi and Aertgeerts (2010) http://www.unece.org/fileadmin/DAM/env/water/whmop2/WHO_Guidance_EWE_Final_draft_web_opt.pdf *(Reviewed by ALM (2013))*
Handbook on Methods for Climate Change Impact Assessment and Adaptation Strategies	UNEP	1 - C	Feenstra et al. (1998) http://www.ivm.vu.nl/en/Images/UNEPhandbookEBA2ED27-994E-4538-B0F0C424C6F619FE_tcm53-102683.pdf *(Reviewed by UNFCCC (2008) and CCCCC (2013))*
How to integrate climate change adaptation into national-level policy and planning in the water sector: a practical guide for developing country governments	Tearfund	1 - C	Venton (2010) http://tilz.tearfund.org/webdocs/Tilz/Topics/watsan/Water%20Adaptation%20Guide_Web.pdf *(Reviewed by ALM (2013))*
Integrated Water Resources Management (IWRM) for climate adaptation – training manual and facilitator's guide	UNDP Cap-Net	1 - C	UNDP Cap-Net (2009) http://www.cap-net.org/sites/cap-net.org/files/CC&%20IWRM%20_English%20manual_.pdf
Methodology guidebook for the assessment of investment and financial flows to address climate change	UNDP Environment & Energy Group	1 - C	UNDP (2009) http://www.undpcc.org/docs/Investment%20and%20Financial%20flows/Methodology/UNDP_IFF%20methodlogy.pdf *(Reviewed by CCCCC (2013))*
Multi-criteria analysis (MCA) for improving water resource management	UNEP MCA4Climate	1 - C	Miller (2011) http://www.mca4climate.info/_assets/files/Water_Management_Final_Report.pdf *(Reviewed by CCCCC (2013))*
Stakeholder-focused cost-benefit analysis in the water sector	International Institute for Environment and Development (IIED)	1 - C	IIED (2013) http://www.iied.org/economics-climate-change-adaptation-water-sector
Testing a Rapid Climate Change Adaptation Assessment for Water	Tom Heath et al.	1 - C	Heath et al. (2012) http://eau.sagepub.com/content/24/2/619.abstract

and Sanitation Providers in Informal Settlements in Three Cities in sub-Saharan Africa			
Water Economy for Livelihoods (WELS) tool	Research-Inspired Policy and Practice Learning in Ethiopia and the Nile Region (RiPPLE) / Overseas Development Institute (ODI)	1 - C	Coulter et al. (2010) / Ludi (2009) http://www.rippleethiopia.org/documents/info/20100521-water-economy-baseline-report http://www.odi.org.uk/publications/3148-climate-change-water-food-security
Water Security and Climate Resilient Development: Strategic Framework & Technical Backgrounder	African Ministers' Council on Water (AMCOW), the Climate and Development Knowledge Network (CDKN), and the Global Water Partnership (GWP)	1 - C	AMCOW et al. (2012) http://www.gwp.org/Global/About%20GWP/Publications/CDKN%20publications/SF_WaterSecurity_FINAL.pdf http://www.gwp.org/Documents/WACDEP/TBD_Final.pdf
SimCLIM	CLIMsystems Ltd.	2 - A	CLIMsystems (2012) http://www.climsystems.com/simclim/index.php *(Reviewed by UNFCCC (2008) and weADAPT (2013))*
A GIS Data Integration Tool for Assessing Stormwater Management Options: User Guide	SWITCH Project – UNESCO-IHE	2 - B	Viavattene (2009) http://www.switchurbanwater.eu/outputs/pdfs/W2-3_GEN_MAN_D2.3.2a_GIS_data_integration_tool_user_guide.pdf
Aquarius	Colorado State University	2 - B	Diaz et al. (2008) http://www.fs.fed.us/rm/value/aquarius *(Reviewed by Garg et al. (2007) and UNFCCC (2008))*
Geoinformation internet portal of the Dniester river basin	UNEP/GRID-Arendal and Zoi Environmental Network	2 - B	UNEP and Zoi (2012) http://82.116.78.174/en/about-geoportal
Improved Risk Assessment for Water Distribution Systems (IRA-WDS) GIS-based risk analysis tool	Kalanithy Vairavamoorthy et al.	2 - B	Vairavamoorthy et al. (2007) http://www.sciencedirect.com/science/article/pii/S1364815206001538
MODSIM-DSS	Colorado State University	2 - B	Labadie (2013) http://modsim.engr.colostate.edu/version8.shtml

RIBASIM	Deltares	2 - B	Deltares (2012) http://www.deltares.nl/en/software/101928/ribasim *(Reviewed by Garg et al. (2007) and UNFCCC (2008))*
RiverWare	Center for Advanced Decision Support in Water and Environmental Systems (CADSWES), US	2 - B	CADSWES (2013) http://www.riverware.org/ *(Reviewed by Garg et al. (2007) and UNFCCC (2008))*
Water Security Index	ADB & the Asia-Pacific Water Forum (APWF)	2 - B	ADB and APWF (2013) http://www.adb.org/sites/default/files/pub/2013/asian-water-development-outlook-2013.pdf
WaterWare	Environmental Software and Services (ESS), Austria	2 - B	ESS (2013) http://www.ess.co.at/WATERWARE/ *(Reviewed by Garg et al. (2007) and UNFCCC (2008))*
Assessing GIS-based Indicator Methodology for Analysing the Physical Vulnerability of Water and Sanitation Infrastructure	Martin Karlson	2 - C	Karlson (2012) http://liu.diva-portal.org/smash/get/diva2:561073/FULLTEXT01
Statistical Downscaling Model (SDSM)	Loughborough University	2 - C	Dawson (2013) www.sdsm.org.uk *(Reviewed by weADAPT (2013))*
Water Evaluation and Planning System (WEAP)	SEI-US	2 - C	SEI-US (2013) http://www.weap21.org/ *(Reviewed by Olhoff and Schaer (2010), Garg et al. (2007), UNFCCC (2008) and weADAPT (2013))*
Water Vulnerability Index, Climate Vulnerability Index, Water Poverty Index[31]	Caroline Sullivan, Jeremy Meigh, et al.	2 - C 2 - C 2 - B	Sullivan (2011) http://epubs.scu.edu.au/cgi/viewcontent.cgi?article=1929&context=esm_pubs

[31] Three similar tools developed by the same authors as semi-progressive iterations, so they are listed here as just one tool to avoid artificially inflating the list

			Sullivan and Meigh (2005) http://hcmus.edu.vn/images/stories/qhqt/hoatdongqhqt/file_2-1.pdf Sullivan et al. (2003) ftp://ftp.fao.org/agl/emailconf/wfe2005/narf_054.pdf
Water World	King's College London (KCL) and AmbioTEK	2 - C	KCL and AmbioTEK (2013) http://www.policysupport.org/waterworld
WaterSim	Arizona State University – Decision Center for a Desert City (DCDC)	2 - C	DCDC (2013) http://dcdc.asu.edu/watersim/
Adaptation Learning Mechanism (ALM)	UNDP et al.	3 - A	ALM (2013) http://www.adaptationlearning.net/ *(Reviewed by GIZ (2009), Olhoff and Schaer (2010) and weADAPT (2013))*
Caribbean Climate Online Risk and Adaptation Tool (CCORAL)	CCCCC	3 - A	CCCCC (2013) http://ccoral.caribbeanclimate.bz/ *(Reviewed by ALM (2013))*
ci:grasp 2.0 (Climate Impacts: Global and Regional Adaptation Support Platform)	Potsdam Institute for Climate Impact Research (PIK) and GIZ	3 - A	ci:grasp (2013) http://www.pik-potsdam.de/cigrasp-2/index.html *(Reviewed by GIZ (2009))*
Climate Adaptation Decision eXplorer (ADx)	weADAPT	3 - A	weADAPT (2013a) http://weadapt.org/knowledge-base/adaptation-decision-making/adaptation-decision-explorer *(Reviewed by CCCCC (2013) and weADAPT (2013))*
Climate Adaptation Knowledge Exchange (CAKE)	EcoAdapt and Island Press	3 - A	CAKE (2013) http://www.cakex.org/
Climate Change Knowledge Portal	The World Bank	3 - A	World Bank (2013) http://sdwebx.worldbank.org/climateportal/index.cfm *(Reviewed by GIZ (2009) and OECD (2009))*
weADAPT	SEI et al.	3 - A	weADAPT (2013b) http://weadapt.org/

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Compendium of Sanitation Systems and Technologies	EAWAG Sandec and WSSCC	3 - B	Tilley et al. (2008) http://www.eawag.ch/forschung/sandec/publikationen/compendium_e/index_EN
Cross-border flood risk management simulation game	FLOOD-WISE	3 - B	FLOOD-WISE (2012) http://floodwise.nl/results/the-game/
Election toolkit: how to campaign on water and sanitation issues during an election	End Water Poverty	3 - B	End Water Poverty (2012) http://www.endwaterpoverty.org/sites/endwaterpoverty.org/files/8783_ElectionToolkit_FINAL1_6_1.pdf
GWP Toolbox for Integrated Water Resources Management	GWP	3 - B	GWP (2008) http://www.gwptoolbox.org/index.php *(Reviewed by Palaniappan et al. (2008))*
Adapting Urban Water Systems to Climate Change: a Handbook for Decision Makers at the Local Level	ICLEI European Secretariat	3 - C	Loftus et al. (2011) http://www.iwahq.org/ContentSuite/upload/iwa/all/Water%20climate%20and%20energy/SWITCH_Adaption-Handbook_final_small.pdf
Climate Change and Urban Water Utilities: Challenges and Opportunities	The World Bank	3 - C	Danilenko et al. (2010) http://www.wsp.org/sites/wsp.org/files/publications/climate_change_urban_water_challenges.pdf
Technologies for climate change adaptation: the water sector	UNEP Risoe Centre on Energy, Climate and Sustainable Development	3 - C	Elliot et al. (2011) http://www.zaragoza.es/contenidos/medioambiente/onu//issue06/1149-eng.pdf

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Overseas Development Institute
203 Blackfriars Road
London SE1 8NJ
Tel +44 (0)20 7922 0300
Fax +44 (0)20 7922 0399