WWF REPORT ZA 2015

AN INVENTORY OF SOUTH AFRICAN

FRESHWATER ECOSYSTEM STEWARDSHIP TOOLS

AND THEIR SUITABILITY FOR USE WITHIN THE RESILIENT LANDSCAPE APPROACH

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1 STRATEGIC INTENT AND OBJECTIVES OF THE INVENTORY

A need was identified for an inventory and assessment of South African freshwater ecosystem stewardship tools as part of a broader, long-term WWF initiative being implemented by the WWF Mondi Wetlands Programme (MWP) termed the Resilient Landscape Approach (RLA) (Cockburn et al. 2014). The RLA is a novel way of working with stakeholders in multifunctional landscapes to build resilience of ecosystems through collaborative learning and localised actions, on the ground, and through agricultural and forestry commodity value chains. These landscapes underpin not only the livelihoods of local communities but also the value chains and markets which depend on agricultural and forestry production in them (Cockburn et al. 2014). A key outcome of RLA is collaborative water resource stewardship, and the aim of this report is to review the many ecosystem assessment and stewardship tools developed in South Africa in order to build a better informed basis for promoting water resource stewardship. The scope of the report is focussed on wetlands and riparian areas, which The Water Act (Act No 36 of 1998) defines as follows.

"**riparian habitat**" includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.

"**wetland**" means land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.

The objectives of the inventory and assessment are as follows:

- Produce an inventory of relevant existing tools for wetland and riparian ecosystem assessment and stewardship, focusing especially on those tools to which MWP contributed.

- Determine the suitability of the tools for use within RLA generally and for contributing to specific needs for implementing the approach, e.g. assessing environmental risks associated with different land-use/management choices.

- Recommend specific refinements required for the tools to enhance their contribution to the resilient landscape approach, focusing especially on those tools to which MWP contributed most.

It is important to add that the inventory of freshwater ecosystem tools will be complimented by an inventory of tools for social learning (Hiesterman in prep.), which is outside the scope of this report. In addition, although the inventory deals with a few tools for in-stream assessment in as far as these have relevance to wetlands, in-stream habitats themselves are beyond the scope of the report.

2 METHODS

The inventory and assessment was undertaken based on the following activities.

- Identify potentially relevant tools, focussing on those developed for South Africa.
- Identify criteria to determine whether a tool is suitable for the Resilient Landscape Approach (RLA) and apply these criteria to the examined tools.
- Conduct interviews with key WWF staff members and a few other key informants regarding their perspectives on suitable tools and RLA.
- Examine existing reviews/critiques of the tools and documentation of the application of the tools, with a focus on their potential contribution towards strengthening collaborative water resource stewardship within the context of RLA.
- Conduct a survey with users of the two primary tools which MWP were involved in developing (namely WET-EcoServices and WET-Health) to see what is working well and what is not working well, in order that lessons can be drawn into any refinements undertaken on the tools.
- Compile the final report which includes recommendations for refinements to WET-EcoServices and WET-Health.

The tools included in the assessment, each briefly described according to what the tool is designed to do and its potential importance for RLA, were confined to those developed for South Africa. The Resilient Landscape Approach (RLA) encompasses many different components (Cockburn et al. 2014), and a tool may have a very specific relevance to only one or a few of these components. Therefore, it is considered inappropriate to judge the suitability of the respective tools for use within RLA based on a single set of criteria. Therefore, for practical purposes, four main components of RLA were identified from Cockburn et al. (2014) and the suitability of each of the individual tools was evaluated against specific criteria relating to each of these components (Table 1). The criteria were framed as primary and secondary questions. Each primary question relates to a key component of RLA, and the questions are therefore very broad. Thus, each primary question was disaggregated into secondary questions in order to aid in the assessment of the tools' suitability for use within RLA.

Table 1: Criteria to guide the assessment of the suitability of tools to the Resilient Landscape Approach

Primary questions	Secondary questions
1. **Is the tool suitable for describing social-ecological systems?**	1a. Does the tool provide an overall framework for representing the interrelationships between the different social and ecological components?
	1b. Does the tool provide an effective means of characterizing the individual components of the social-ecological system?
	1c. Does the tool make explicit reference to resilience or at least to the concepts of system change, recovery and thresholds of change?
2. **Is the tool suitable for assessing values and risk?**	2a. Is the tool suitable for identifying and valuing ecosystem services provided by wetlands and riparian ecosystems, including regulatory, provisioning and cultural services?
	2b. Is the tool suitable for evaluating ecological condition of wetlands and riparian ecosystems?
	2c. Does the tool explicitly deal with assessing environmental risk?
3. **Is the tool suitable for promoting sound governance and legal compliance?**	3a. Is the tool suitable for building a shared understanding of governance in a broad sense, including rights, responsibilities and authority, and for identifying sound operating principles, e.g. authority must be accessible, exercised and co-operative?
	3b. Does the tool provide specific guidance for users of wetlands and riparian systems to assess their compliance with all of the relevant legislation?
4. **Is the tool suitable for promoting social learning and adaptive management?**	4a. Does the tool provide explicit guidance for bringing people from different backgrounds together in a "safe space" to share knowledge and experience, develop new knowledge, and harness conflict and contradiction as important triggers of learning?
	4b. Does the tool provide explicit guidance for managers to engage in successive cycles of action, monitoring, reflection, and modified action (i.e. a reflexive approach) designed to lead to a progressive improvement in management competency?

It is recognized that there may be considerable overlap in terms of the components/ questions. In particular, all of the other components relate to the first component, i.e. of describing the social-ecological system. Thus, a tool which contributes to building an understanding of governance will also contribute to describing the social-ecological system given that governance is an important dimension of the social system and influences how the social system affects the ecological system.

Given the vast sweep of issues covered by RLA and the considerable number of potentially suitable tools, it is problematic to only consider the tools individually. Therefore, in addition, the primary questions which were addressed for each individual tool were reframed as follows in order to consider how effectively the tools might work together. Do we have a suitable mix of tools available with which to:

- Effectively describe the social-ecological system?

- Effectively assess ecosystem values and risk?

- Effectively assess governance and legal compliance?

- Effectively assess social learning and adaptive management?

A brief questionnaire (Appendix A) was used to conduct a survey with users of the two primary tools which MWP were involved in developing (namely WET-EcoServices and WET-Health) to see what is working well and what is not working well. The questionnaire was circulated through the National Wetlands List Server.

In terms of the scope of this review, it is important to note that the social learning component is being reviewed as a separate review (see Hiesterman in prep.). In addition, the review did not include tools developed specifically for the assessment of corporate sustainability, corporate social responsibility and supply-chain sustainability, and specifically the assessment of risks which ecosystem degradation can pose to corporate performance, including operational, regulatory, reputational, market and financing risks (Hanson et al. 2012). Finally, it is important to add that there are likely to be some biases associated with the fact that the author of the review is also the author of several of the tools under review. In order to try and minimize such biases, the review itself was subject to a third party review by Dr Mark Graham of GroundTruth.

3 A SUMMARY OF THE BROAD-SCALE ASSESSMENT OF SUITABILITY OF TOOLS FOR USE WITHIN RLA

Table 2 presents the results of the assessment of all of the tools identified as being potentially suitable, based the criteria given in Table 1 for suitability for use within RLA. A key trend in the results which is immediately apparent in Table 2 is that no tool is suitable for all of the components considered in the RLA. In fact, no one tool comes anywhere near properly addressing even half of all of the elements of RLA which were considered. This is not surprizing given the considerable breadth of RLA, which highlights the importance of using different tools to complement each other. From the overall assessment in Table 2 (see final row) and Table 3 it can be seen that certain components of RLA are much better covered than others. The greatest gap is specific guidance for users of wetlands and riparian systems to assess their compliance with all of the legislation relevant to these areas. Another notable gap appears to be guidance for promoting social learning. However, it is noted that the nature of social learning is such that generic guidelines, notably those of Wals et al. (2009) are likely to be applicable to most countries, and guidance specifically tailored for RLA is being developed by Hiesterman (in prep). Although the assessment of risk is a gap which no single tool covers comprehensively, it is dealt with from different perspectives by several tools.

Table 2: **Suitability of the tools reviewed to the key components and sub-components of the Resilient Landscape Approach applied to catchments and wetland ecosystems**

	Key components (1 to 4) and sub-components (a, b, c)									
Potentially relevant tools	1. Describing the social-ecological system			2. Assessing benefits & risks			3. Gover-nance / compliance		4. Social learning/ adaptive management	
Specific secondary questions given in column 2 of Table 1:	1a	1b	1c	2a	2b	2c	3a	3b	4a	4b
Delineation and ecosystem typing										
Wetland/riparian delineation guidelines (DWAF 2005) ①		*****								
Desktop wetland delineation & assess (Dayaram et al. 2014) ①		***		*						
Wetland classification (Ollis et al. 2013)		*****								
Ecological condition assessment										
WET-Health (Macfarlane et al. 2009) ①		*****			****	**				
Wetland Index for HI (DWAF 2007) ①		*****			**	*				
Water Quality Assessment based on land-cover (Malan et al. 2013)		*****			**	**				
River IHI (Kleynhans et al. 2009; Graham & Louw 2009)		*****			***	**				
VEGRAI (Kleynhans et al. 2007)		****			***	*				
Ecological Reserve Determination - wetlands (Rountree et al. 2013)		***				***				
SASS 5 for bioassessment of rivers (Dickens and Graham 2002)		**			**					
MiniSASS for bioassessment of rivers (Graham et al. 2004)		**			**					
Assessment of the provision of ecosystem services										
WET-EcoServices (Kotze et al. 2009) ①		*****		*****						
Quantification of ecosystem services (Turpie and Kleynhans 2010)		*****		*****						
Assessment of the livelihood value of wetlands (Turpie 2010)		*****		*****						
Wetlands and wellbeing: A Decision Support System (Kotze 2014)	*	***		***		**				

Adaptive management										
Protocol for the definition of the desired state of riverine systems (Rogers and Bestbier 1997)			**							****
Strategic adaptive management guidelines for freshwater ecosystems (Kingsford and Biggs 2012)			**							*****
Integrating wetlands in catchment planning (Dickens et al. 2004) ①	***	*	*	*	*	*	*		*	*****
Sustainable use guidelines										
Wetland Fix (Wyatt 1997) ①		**		*						
Wetland-Use and booklets (1997a and b; Kotze 2000)		**		***						
WET-SustainableUse (Kotze 2010)	*	**		****	***	**	**			
Sustainability indicators: Craigieburn wetland (Pollard et al. 2009)	**	***	*	***			****		**	
Wetland management guidelines for forestry (Kotze 2011a) ①		***		***		**				
Sustainable sugar management system SusFarMS® ①						**		***		**
Buffer guidelines: aquatic ecosystems (Macfarlane et al. in press)				***		**	***			
Alliance for Water Stewardship Standard	**	*		**		**	*			*****
Institutions										
A review of community-based governance of water resources (Pollard and Cousins 2008)	**						****			
A Wise Use approach (Pollard and Sefatsa 2014) ①							*		****	*
Wetlands and wellbeing: A review with cases (Hay et al. 2014)	***		**						**	
WET-Legal (Armstrong 2009)							*	***		
Overall assessment of the degree to which the question can be addressed based on the suitability of available tools and the degree to which the tools complement each other[1]	***	****	***	****	****	**	****	*	**	****

Suitability:
- * = Generally not suitable but potentially could make a minor contribution;
- ** = Suitable, but to a moderately low degree;
- *** =Suitable to a moderate degree;
- **** = Suitable to a moderately high degree;
- ***** = Suitable to a high degree

[1]It is important to note that even if some individual tools have high suitability, important gaps may still remain in terms of fully addressing all of a key component.

① Tools to which MWP contributed to developing.

Table 3: Comments relating to whether the tools reviewed collectively address the four key examined components of the Resilient Landscape Approach applied to catchments and wetland ecosystems

Key components of RLA	Comments
Effectively describe the social-ecological system	Describing the social-ecological system is reasonably well covered by existing tools, including overall frameworks which explicitly deal with linkages between the social and the ecological sub-systems. However, the focus of most detailed descriptions within existing tools is mainly on the ecological sub-system.
Effectively assess ecosystem values and risk	Assessing ecosystem values is reasonably well covered by existing tools, but explicit coverage of risk is fairly limited.
Effectively assess governance and legal compliance	Governance generally is moderately well covered by existing tools. However, there is a clear lack of practical guidelines relating to the many laws designed to protect wetlands (including NEMA, National Water Act, and CARA) and what needs to be done to remain compliant with these. As it stands, WET-Legal focuses on the legislation relating specifically to the rehabilitation of wetlands, and needs to be greatly expanded.
Effectively assess social learning and adaptive management	Several frameworks exist both in South Africa and internationally for promoting and guiding strategic adaptive management. Tools for promoting and guiding social learning have been developed internationally, notably Wals et al (2009), are likely to have applicability to South Africa in that the principles and techniques described are not specific to any one country.

SASS 5 (Dickens and Graham 2002) and MiniSASS (Graham et al. 2004) were designed specifically for river/streams, and are not suitable for applying directly to wetlands (Bird 2010). However, they were included in the review as they may have application where there is a need for bio-assessment of water quality in streams/ rivers flowing into, through or out of wetlands.

4 BRIEF DESCRIPTIONS OF THE TOOLS AND THEIR RELEVANCE TO RLA

In this section the tools assessed in Table 2 are each briefly summarized in terms of what they are designed to do and why they are potentially important for RLA. Tools to which MWP contributed to development are indicated as 1. Tools which were assessed in Table 2 as having only a moderately low or lower suitability (i.e. tools scored ** or *) for the components of RLA are excluded from the summary. Tools which have been superseded by other tools are also excluded, although it is recognized that some may have played a critical role in the historical development of other tools. Of note is the Riparian Vegetation Index (RVI) (Kemper 2001) which has been superseded by VEGRAI ((Kleynhans et al. 2007) and Wetland-use (Kotze 2000) which has largely been superseded by WET-SustainableUse (Kotze 2010).

4.1 Tools relating to delineation and ecosystem typing

A practical field procedure for identification and delineation of wetlands and riparian areas (DWAF 2005) 1:
This manual describes standardized, field indicators and methods for determining whether an area is a wetland or riparian area, and for locating its boundaries. The basis for wetland delineation are four main field indicators: (1) the terrain unit indicator to help identify those parts of the landscape where wetlands are most likely to occur; (2) the soil form indicator which identifies those soil forms associated with prolonged and frequent saturation; (3) the soil wetness indicator which identifies the morphological "signatures" which develop in the soil profile as a result of prolonged and frequent saturation; and (4) the vegetation indicator which identifies hydrophilic vegetation associated with frequently saturated soils. Similarly, indicators for riparian areas are provided, including topography, vegetation and alluvial/ depositional material.

The tool, which is designed for application by wetland/riparian practitioners, applies across a diversity of contexts, including agriculture, forestry and urban. It is important for RLA because one of the first steps in managing an ecosystem, whether at a local level or a broad catchment-wide level, is to establish where the ecosystem is located and how extensive it is. To achieve this it is necessary to determine the boundary of the ecosystem, which in the case of wetlands and riparian areas is difficult to delineate due to water table fluctuations through the year, requiring that long-term integrators of water regime be used, e.g. soil morphology and vegetation.

Available from: http://www.dwaf.gov.za/Documents/Other/EnvironRecreation/wetlands/WetlandZoneDelineationSep05Part2.pdf

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Quick guide to desktop identification, delineation and assessment of the health of wetlands using GIS software (Dayaram et al. 2014) 1:
The guide provides step-by-step guidance for non-specialists to identify and delineate wetlands using Google Earth and QGIS, which is open access GIS software. It includes many graphics and practical examples. The desktop focus of these guidelines helps to compliment the field guidelines of DWAF (2005). Presently the guidelines deal fairly superficially with the desktop assessment of wetland health, but do provide guidance for identification of a variety of impacts, including dams, artificial drainage channels and erosion gullies.

As indicated, it is important for RLA to establish where wetlands are located and how extensive they are at a broad landscape or catchment scale, and therefore tools such as the quick guide have a potentially useful contribution to make to RLA.

Available from: The guideline is still under development, but a draft is available from David Lindley (dlindley@wwf.org.za) on request.

Classification system for wetlands and other aquatic ecosystems in South Africa (Ollis et al. 2013):
This represents the most up-to-date classification system for inland wetlands and other aquatic ecosystems in South Africa, which builds on earlier national classification systems. Three broad types of inland systems are dealt with by the system: (1) rivers, comprising flowing water in a distinct channel; (2) open water bodies; and (3) wetlands, which are transitional between terrestrial and aquatic. The classification system has a tiered structure, progressing from regional setting to landscape unit and hydrogeomorphic type, which is the focal point of the system. Further distinctions are then made based on hydrological regime, water depth, etc. The classification system is designed for use by both specialists and non-experts, and is user-friendly, with many illustrations and photographs.

A functional classification of wetlands, from which ecological processes and ecosystem services can be inferred from wetland type, is important to RLA because in order to manage key aquatic/wetland ecosystems across extensive landscapes it is not practical to directly describe the ecological processes taking place within of individual wetlands but rather to rely upon inference. In this way, if the hydrogeomorphic type is identified, then tools such as Kotze (2014) can be used to infer ecological services likely to be supplied by these types.

Available from: http://www.sanbi.org/sites/default/files/documents/documents/sanbi-biodiversity-series-wetlands-classification-no-22.pdf

4.2 Tools for the assessment of ecological condition

WET-Health (Macfarlane et al. 2009) 1:
WET-Health is a modular-based approach for evaluating and monitoring the Present Ecological State (health) of a wetland and its projected trajectory of change. It attempts to account for some of the key interacting processes that take place within a wetland and synthesize this information by evaluating three inter-related components of health: (1) *Hydrology* which can be altered through (a) changes in water inputs as a result of human activities in the catchment upstream of the wetland or (b) modifications within the wetland (notably those resulting from the excavation of artificial drainage channels) that alter the water distribution and retention patterns within the wetland; (2) *Geomorphology*, which is defined as the distribution and retention patterns of sediment within the wetland, including both clastic sediment (mineral particles) and organic sediments. This module focuses on evaluating changes in erosional and depositional patterns within the wetland as a result of human activities; and (3) *Vegetation* which is assessed by evaluating changes in vegetation composition as a consequence of current and historic on-site disturbance, and includes consideration of the extent of total removal of the indigenous vegetation and its replacement (e.g. by planted crops) as well as the extent to which areas of natural or semi-natural vegetation have altered composition

through increased abundance of ruderal (weedy) or invasive plants. WET-Health provides the user with two levels of detail for conducting the assessment: Level 1 which is mainly desk-top based and Level 2 which involves the rapid description of field indicators.

WET-Health is important to RLA because a key element of RLA is maintaining the functionality of landscapes, of which wetlands are generally a particularly important component, and therefore a means is required to assess the ecological health of wetlands.

Available from: http://www.wrc.org.za/pages/KnowledgeHub.aspx
Note: all tools published by WRC can be located on the WRC Knowledge hub by searching on the website using the title of the tool. In addition, if a hard copy is required then this can be ordered free of charge from orders@wrc.org.za by supplying them with the title and WRC number (see references).

A Wetland Index of Habitat Integrity for South African floodplain and channelled valley bottom wetland types (Wetland-IHI) (DWAF 2007):
Wetland-IHI was developed for the purpose of determining the Present Ecological State of certain wetland types within the wetland component of the National Aquatic Ecosystem Health Monitoring Programme of Department of Water and Sanitation (DWS, previously known as DWA and DWAF), as well as for use within the Ecological Reserve determination process. Wetland-IHI is similar to WET-Health in terms of its discrete components, namely hydrology, geomorphology and vegetation/land-use. However, the approach and method are more closely aligned with existing DWS tools, notably IHI for rivers (Kleynhans 1996; Kleynhans et al. 2009). The tool was designed for application by non-specialists and is undertaken at a low level of detail, in contrast with WET-Health which can be applied at two different levels of detail.

As indicated, RLA requires assessment of the functionality of landscapes, including assessing the ecological state of wetlands, for which WET-IHI can make a potentially important contribution, particularly in the context of DWS assessments.

Available from: http://www.dwa.gov.za/iwqs/rhp/wetlands/WETLAND_IHI_final.pdf

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A tool for assessing water quality impacts on wetlands based on land-use in the catchment (Malan et al. 2013):
This tool provides an impacts-based approach using land-use in the catchment surrounding the wetland for assessing the Present Ecological State (PES) of a wetland in terms of water quality. A land-use/water quality model was developed in the form of a spreadsheet which has relevance to both wetlands and riparian areas. The spreadsheet provides a list of land-uses (irrigated cropland, etc) each of which has already been rated from 0 (no impact) to 5 (major impact) for the contaminants likely to be generated as runoff. The user is required to estimate the extent of the different land-uses, and a tentative PES Category is generated by the spreadsheet model, which can then be adjusted based on other factors (e.g. the presence of a vegetation buffer around the wetland).

As indicated, a key element of RLA is maintaining the functionality of landscapes, including wetlands, and therefore a means is required to assess the ecological state of wetlands. One of the important ways in which the ecological state of a wetland (or riparian area) can potentially be compromised is through changes in water quality. However, neither WET-Health nor Wetland-IHI deal adequately with water quality impacts on wetlands (Ollis and Malan 2014). Thus the tool of Malan et al. (2013) compliments these two tools very well.

Available from: http://www.wrc.org.za/pages/KnowledgeHub.aspx

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Index of Habitat Integrity (IHI) for Rivers, a technical manual (Kleynhans et al. 2009; Graham and Louw, 2009):
The manual is designed to support for the execution of the Index of Habitat Integrity model. It provides step-by-step guidance on how to run the model and the primary premises on which it is based. Habitat integrity assessment is assessed in two components: instream and riparian zone, each with a number of metrics that enable the assessment of habitat integrity based on an interpretation of the deviation from the reference condition. An impact based approach is followed, where the intensity and extent of anthropogenic changes are assessed. The riparian zone assessment is based on three metric groups: (1) Hydrological modification, including (a) baseflow, (b) zero flow (c) Moderate floods and freshes and (d) large floods, which play a specific role in the functioning and geomorphic characteristics of the riparian zone; (2) Bank structure modification, based on a separate rating of marginal and non-marginal areas in terms of substrate exposure, invasive vegetation, physico-chemical changes, erosion and channel straightening; and (3) Lateral and longitudinal connectivity of the riparian zone. To assist with standardisation and quality control in the application of IHI and the technical manual, a practical photo guide (Graham and Louw, 2009) was developed.

Together with wetlands, riparian areas play a potentially important role in maintaining the health of landscapes, which is a key element of RLA, and therefore a means is required to assess the ecological state of riparian areas, which the tool is specifically designed to do.

Available from: http://www.wrc.org.za/pages/KnowledgeHub.aspx

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VEGRAI (Kleynhans 2007):
The Riparian Vegetation Response Assessment Index (VEGRAI) (Kleynhans 2007) is designed for qualitative rating of the response of riparian vegetation to impacts, with a suite of rules converting the multiple ratings into an Ecological Condition. Marginal zone (wet bank), lower zone (wet bank, continued) and upper zone (dry bank) are scored separately and then the scores are integrated. VEGRAI includes two levels: Level 3 for application in the River Health Programme (RHP) and for rapid Ecological Reserve purposes, aimed at general aquatic ecologists; and Level 4 for application in the intermediate and comprehensive Ecological Reserve determinations, aimed at specialist riparian vegetation ecologists. Several metrics are defined and used in VEGRAI to describe and rate riparian vegetation status. These are abundance, cover, species composition, recruitment and population structure, with the latter two only carried out for woody plants at a Level 4 assessment. Cover is taken as aerial cover and Abundance is taken as number of stems/plants per unit area. Both cover and abundance addresses the question of

how much vegetation there is under present condition compared to how much there should be under reference condition.

As indicated for the previous tool, riparian areas play a potentially important role in maintaining the health of landscapes, and therefore a means is required to assess the ecological state of riparian areas. Furthermore, the riparian vegetation itself is pivotal to the functioning of the riparian zone, and VEGRAI provides specific guidance for assessing this vegetation.

Available from: http://www.dwa.gov.za/iwqs/rhp/eco/EcoStatus/ModuleF_VEGRAI/ModuleF_VEGRAI.pdf

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A Manual for the Rapid Ecological Reserve Determination of Inland Wetlands (Rountree et al. 2013):

This manual provides the technical information (or references to appropriate existing methods) for the Rapid level of Reserve Determination for wetlands of all types (excluding lakes, since the size, complexity and rarity of these wetland types in South Africa precludes them from rapid, low confidence assessments). The Ecological Reserve refers to the allocation of water required by the National Water Act that for a wetland to maintain its ecological integrity. The Rapid level of Reserve determination requires a small team of specialists to undertake fast assessments of the wetland resource in question. Guidance is provided for defining the study area boundaries and for selecting the correct specialists to the study team based on considerations such as wetland size, type and hydrological complexity and the likely ecological, functional and social importance of the wetland/s. Further guidance is provided for field assessments to determine the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the wetland, as well as to collect critical data to quantify ecological water requirements for the wetland. Next, guidance is provided for determining ecological water requirements of the wetland, i.e. how much water, and of what quality, should remain in the system. This requires understanding of how the flow quantity and pattern have changed over time and how the current situation deviates from the natural condition and then how to translate this hydrological understanding into the various biophysical/ecological impacts which are occurring (under PES) or which may result (as in the evaluation of future scenarios) within the wetland system being evaluated.

Ecological Reserve Determination is important to RLA because a key element of RLA is maintaining the functionality of landscapes, of which wetlands are generally a particularly important component, and therefore a means is required to assess whether the water needs of these wetlands are being met, particularly for key wetlands in the landscape/catchment. Given the high level of expertise required, Reserve Determinations can be costly but are critical for key wetlands in sub-catchments with a high level of human water use.

Available from: http://www.wrc.org.za/pages/KnowledgeHub.aspx

4.3 Tools for the assessment of the provision of ecosystem services

WET-EcoServices (Kotze et al. 2009) 1:
WET-EcoServices was developed to help non-specialists assess the ecosystem services that individual wetlands supply in order to allow for more informed planning and decision-making. The process of applying WET-EcoServices begins with the characterisation of hydrogeomorphic wetland types. Individual wetlands are then assessed either at a desktop assessment level (Level 1) or at a rapid field assessment level (Level 2) where 15 benefits are assessed. Regulatory and supporting benefits (e.g. toxicant removal, sediment trapping, erosion control and flood attenuation) and cultural and provisioning benefits (e.g. tourism and recreation, provision of water and natural resources such as reeds for human use) are included. In a Level 1 assessment, ecosystem services are assigned to a particular wetland based on existing knowledge of the features associated with different hydrogeomorphic types since different HGM types offer different ecosystem services. For example, floodplains characteristically contribute effectively to the attenuation of floods. A Level 2 assessment is undertaken based on a desktop synthesis of available data followed by a rapid field assessment. Each of 15 services may be assessed based on a list of characteristics (e.g. slope of the wetland) that are relevant to the particular service. Each characteristic used in the system has an information box which provides the rationale for the choice of characteristics and has directions on how to assign scores. Therefore the logic behind the system is open to scrutiny.

WET-EcoServices is important to RLA because one of the cornerstones of RLA is that the supply of ecosystem services is sustained in the long-term, and without the means to assess ecosystem services supply, it is not possible to know if this is being attained.

Available from: http://www.wrc.org.za/pages/KnowledgeHub.aspx

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A protocol for the quantification and valuation of wetland ecosystem services (Turpie and Kleynhans 2010):
This report is written for the use of planners and decision-makers wishing to understand the purpose and potential for use of wetland valuation in a variety of decision-making contexts, and to guide them in the setting of terms of reference for specialist studies. In addition, the report aims to guide student and professional resource economists in their understanding of the purpose of and trade-offs in valuation studies, the choice of their detailed methodological approach, and the role of biophysical specialists in wetland valuation. Although the report provides advice on how to achieve relatively rapid estimates of wetland values, it does not offer a shortcut tool for rapid valuation by non-professionals. Specific guidance is provided for: (1) determining the level of comprehensiveness required for a valuation study; and (2) selection of valuation methods required to quantify and value key wetland services at different levels of comprehensiveness and different spatial scales.

As indicated, one of the cornerstones of RLA is that the supply of ecosystem services is sustained, and therefore the means to assess ecosystem services supply is required. While WET-EcoServices assists at scoping level to identify important ecosystem services supplied by individual wetlands, it does not go as far as assisting in the quantification of these services, which the tool of Turpie and Kleynhans (2010) is specifically designed to do.

Available from: http://www.wrc.org.za/pages/KnowledgeHub.aspx

A Tool for the Assessment of the Livelihood Value of Wetlands (Turpie 2010):

The main aim of this tool is to provide a simple index for the assessment of a wetland's importance to people's livelihoods through understanding of the level of dependence of surrounding communities on the wetland. The tool outlines the way in which the index parameters are estimated at a rapid, intermediate, or comprehensive level. The results can be used to assess the relative importance of a wetland for livelihoods compared to other wetlands in a catchment, and to prioritize amongst the different wetlands. The index can also be applied when investigating the implications of different future scenarios. The index developed here can be used in conjunction with existing South African indices such as WET-Health.

An important element of RLA is sharing the benefits which accrue from ecosystems, and the recognition that the ecosystems in a landscape underpin the livelihoods of local people in particular. It is therefore important to determine the level of dependency of local livelihoods on wetlands in a landscape, which the assessment tool of Turpie (2010) is specifically designed to do.

Available from: http://www.wrc.org.za/pages/KnowledgeHub.aspx

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Wetlands and wellbeing: a decision support system (DSS) (Kotze 2014):

The DSS is designed to assist with the following: (1) assessing the supply of ecosystem services by a particular wetland; (2) exploring how different use-scenarios might affect the suite of ecosystem services supplied by a particular wetland; (3) assessing the current demand and use of the services supplied by a wetland; (3) identifying opportunities (for enhancing benefits) and risks to the provision of ecosystem services by a wetland; (4) assessing the costs, particularly to local people, of a wetland, for example provision of habitat for disease vectors; and (5) identifying possible means of addressing the risks to, and costs of, a wetland and of realizing the most promising opportunities. This tool draws extensively from WET-EcoServices, and the rationale underlying the DSS is explicitly provided, which allows for the scientific basis of the system to be scrutinized. The DSS has been applied in full to two case examples.

A key aspect of RLA is the supply of ecosystem services, and therefore methods are required to assess this supply. As will be elaborated upon in Section 4, the DSS compliments the other available tools particularly those of Kotze et al (2009) and Turpie (2010), in terms of the specific guidance it provides for inferring ecosystem provision from the wetland's hydrogeomorphic type and for identifying opportunities and risks, which inadequately addressed by the other available tools.

Available from: http://www.wrc.org.za/pages/KnowledgeHub.aspx

4.4 Tools for adaptive management

Strategic adaptive management guidelines for effective conservation of freshwater ecosystems in and around protected areas (Kingsford and Biggs 2012):

This guide is aimed at researchers, policy makers and practitioners. The stimulus for this guide came from within the protected area management community but it can be applied directly to any catchment, even those with limited or even no protected areas. The approach follows a structured path adapted to help managers and policy makers operating in heterogeneous land-use mosaics influenced by the dynamic complexity of multiple interacting social and ecological factors. The lessons contained here should also help managers charged with the management of environmental flows. The tool defines Strategic Adaptive Management and describes the stepwise implementation of the framework, including: Step 1, setting the desired future ecological condition; Step 2, management options; Step 3, operationalisation; Step 4, evaluation and learning.

Recognizing the complexities of managing dynamic landscapes which are not well understood, one of the foundations of RLA is adaptive management and learning. Therefore guidelines such as those provided by Kingsford and Biggs to help structure such management and learning have a potentially very important role to play.

Available from: https://portals.iucn.org/library/efiles/documents/2012-017.pdf

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Guidelines for integrating the protection of wetlands into catchment planning (Dickens et al. 2004) 1:

The guidelines provide a template on which catchment management agencies and other agencies responsible for water management will be able to implement wetland management in their areas. Central to the template is a critical path which intends to help agencies navigate through the following steps (1) developing a shared vision; (2) planning and prioritization at catchment level; (3) setting objectives and building wetlands into the catchment management strategy; (4) planning and implementing practical actions; (5) monitoring progress and initiating interventions; (6) reviewing and improving for the next management cycle. The approach essentially applies strategic adaptive management at the scale of a catchment. As an aside it is suggested that these guidelines were, in a sense, ahead of their time because although they have been taken up internationally and adopted by Ramsar they have largely failed to be implemented in South Africa.

RLA encompasses water stewardship from a broad scale down to practical actions at a local scale, which is the same scope of the guidelines of Dickens et al. (2004). In addition, both RLA and the guidelines of Dickens et al. (2004) follow an adaptive management approach. Thus the guidelines have a potentially important contribution to make to developing the over-arching template of RLA.

Available from: http://www.wrc.org.za/pages/KnowledgeHub.aspx

4.5 Sustainable use guidelines

Sustainability indicators in communal wetlands and their catchments. Lessons from Craigieburn wetland (Pollard et al. 2009):

This report is aimed at both researchers and practitioners. It covers both the biophysical and social/governance realms. It is a useful reference when thinking about the question: how do we know, going into the future, whether the contribution of the wetland to wellbeing is continuing to be sustained? It provides several sub-sets of indicators which might be used for monitoring attainment of this goal. It was specifically developed for a single case study wetland, but the approach and several of the indicators are likely to have wide application, particularly for wetlands under communal tenure which are cultivated.

The RLA will require monitoring and appropriate indicators in order to determine whether its objectives are being attained, particularly with respect to adaptive management. This report provides some potentially useful indicators and approaches applicable to both communal and privately owned areas.

Available from: http://www.wrc.org.za/pages/KnowledgeHub.aspx

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WET-SustainableUse, a system for assessing the sustainability of wetland use (Kotze 2010):

WET-SustainableUse has been developed to assist with the assessment of the environmental sustainability of wetland use. It focuses on the grazing of wetlands by livestock, the cultivation of wetlands and the harvesting of wetland plants for crafts and construction, which are three of the most widely encountered uses of wetlands in South Africa. Ecological sustainability of a particular use of a wetland is assessed through scoring the impact of the use on the following components of the wetland's ecological state: (1) retention and distribution of water; (2) retention of sediment (and its loss by erosion); (3) storage of soil organic matter; (4) retention and cycling of nutrients (and other elements); and (4) maintenance of the native vegetation composition (diversity). Each component consists of a set of metrics that are combined in a simple algorithm to represent how that component is affected by use in a way that is closely aligned with that of WET-Health. The rationale behind the selection of each of the metrics is provided, together with the rationale for combining the scores of the different metrics into a single score. WET-SustainableUse also includes consideration of how tenure, governance and other socio-economic factors might influence the sustainability of use, and it assists the user in placing the assessment in a broader socio-economic and institutional context.

A key goal of RLA is use of landscapes and the ecosystems for human production while at the same time maintaining critical ecosystem function. In order to promote this goal, a sound understanding is required of how different production practices are likely to affect ecosystem function. This is a key focus of WET-SustainableUse for wetlands and some of the most commonly applied agricultural uses of wetlands in South Africa.

Available from: http://www.wrc.org.za/pages/KnowledgeHub.aspx

Guidelines for managing wetlands in forestry areas (Kotze 2004) :
In many forestry estates, wetlands occupy much of the unplanted riparian corridors between plantation compartments, forming the "backbone" of the plantation's natural open areas. As with all land-uses, there are environmental impacts associated with timber production, including: water use by the plantation trees, thereby diminishing the supply to wetlands; invasion by alien plants; potentially harmful burning practices, especially the extremes of over-protection from fire and from burning too frequently; roads, which may potentially increase sediment loads and disrupt water flow patterns; and a reduction in the connectivity that individual wetlands possess with other natural areas in the landscape. In order to determine whether a forestry company is achieving its environmental management objectives, measurable management targets are required for assessing the success of open area management. The guidelines given in this document are aimed at supporting forestry managers in minimizing the impact of all forestry and other operations (e.g. burning) on wetlands, by applying best management practices. They also aim to promote and facilitate the sustainable utilization of Mondi's wetlands (e.g. through grazing or craft production from wetland plants). These best management practice guidelines have been supplemented by guidelines for "screening" of the wetlands in a forestry estate to identify those areas which are most sensitive to inappropriate burning and to set burning management targets (Kotze 2011a).

As indicated, RLA requires a sound understanding of how different production practices are likely to affect ecosystem function. Some landscapes, in the KwaZulu-Natal midlands, for example, have extensive plantation forestry, and guidance is therefore required on how to limit the environmental impacts of forestry management for its unplanted natural areas.

Available from: http://www.wetland.org.za/TechnicalInfo.html

Sustainable Sugarcane Farm Management System, SusFarMS® :
There is an increasing demand from consumers and major purchasers that sugar conform to environmentally and socially acceptable principles. SusFarMS® is designed to help farmers monitor and verify their social and environmental legal compliance and implementation of better management practices (BMPs). BMPs are designed to reduce negative impacts on society and the environment and increase efficiencies and yields, thus promoting financial sustainability. SusFarMS® provides principles, criteria, indicators and verifiers, which support relevant international and South African legislation, and are applied by means of the BMPs. The three main principles are: economically viable sugarcane production is maintained or enhanced; the rights of employees and the local community are upheld and promoted; natural assets are conserved, critical ecosystem services are maintained and agricultural resources are used sustainably. A Progress Tracker check-sheet is provided for the grower to determine the current performance level and to evaluate progress in relation to the criteria and indicators.

As indicated, RLA requires a sound understanding of how different production practices are likely to affect ecosystem function. Some landscapes, in the KwaZulu-Natal coastal region in particular, have extensive areas of sugar, and guidance is therefore required on how to limit the environmental impacts of sugar management on the environment generally and water resources specifically. In addition, an important element of RLA is strengthening mechanisms for producers to account for the social and environmental consequences of their production (mainly through legal compliance) and in return assisting the producers to secure access to markets requiring a certain level of environmentally and socially responsible production, which is the core of SusFarMS®.

Available from: South African Sugar Research Institute, Extension Department Head, PO Box 700, Mount Edgcombe, 4300, South Africa. +27 (0)31 508 7000, sasri@sugar.org.za

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A methodology to determine appropriate buffer zones for developments associated with wetlands, rivers and estuaries (Macfarlane et al. in press):
The assessment procedure for determining appropriate buffer zones takes into consideration: (1) the aquatic impact buffer zone; (2) potential core habitats; (3) potential ecological corridors; and (4) relevant additional mitigating measures. A step-by-step approach is followed, including: Step 1, define objectives and scope of the assessment and determine the most appropriate level of assessment; Step 2, map and categorize water resources in the study area; Step 3, refer to the Department of Water Affairs and Sanitation management objectives for mapped water resources or develop surrogate objectives; Step 4, assess the risks from proposed developments and define mitigation measures necessary for protecting mapped water resources; Step 5, assess risks posed by proposed development on biodiversity and identify management zones for biodiversity protection; Step 6 delineate and demarcate recommended setback requirements; Step 7, document management measures necessary to maintain the effectiveness of set-back areas; and Step 8, monitor implementation and review effectiveness.

As indicated, RLA requires a sound understanding of how different production practices are likely to affect aquatic ecosystem function and how these impacts can be limited. This includes not only production/land-use directly within an ecosystem but also upslope of a wetland. Guidance is therefore required on an appropriate buffer zone between the land-use and the aquatic ecosystem, and therefore the guidelines of Macfarlane et al. (in press) fulfil an important need of RLA.

Available from: http://www.wrc.org.za/pages/KnowledgeHub.aspx (The document is in the process of being published and is yet to be loaded onto the WRC Knowledge Hub)

Alliance for Water Stewardship Standard (Alliance for Water Stewardship, 2014):
This standard is new and in the process of becoming established. It is included in this review despite it being international, mainly because it has received considerable attention and testing in South Africa by WWF and other organisations. The AWS standard has been designed as an enabling tool for businesses from a variety of sectors (including farms and processing plants in agriculture) to commence and map their own cyclic and ongoing water stewardship journey. The six steps in the standard are (1) commit, (2) gather and understand, (3) plan, (4) implement, (5) evaluate and (6) communicate and disclose. The standard has two levels, core and advanced, in order to allow corporations to gain increasing depth and detail in their water stewardship actions, as they continually work through the six steps. The four outcomes the standard supports are (1) good water governance, (2) sustainable water balance, (3) good water quality status and (4) healthy status of important water

related areas. The strength of the standard is its design to ask water stewardship questions to variously sized corporates of various sectors (mining, retail, processing, agriculture, etc.), or to even look into water stewardship in a supply chain. The first steps focus on understanding in-house social, ecological, economic and technical water issues, as well as understanding the same issues within the catchment in which operation takes place. The initial steps assume that improvements will be enacted in-house, while later, advanced criteria also require collective action beyond the fence, with other catchment stakeholders. The drawback of the standard is its international and high-level nature, highlighting areas where improvement is needed, but not providing sector and country-specific guidelines for improvement. Such detail would need to be obtained from other tools and databases.

As indicated, RLA requires a sound understanding of how different production practices are likely to affect aquatic ecosystem function and how these impacts can be limited. The standard is well-poised to identify key water issues at a site specific scale, and how that relates to water stewardship issues within the broader catchment. The broad applicability of this standard across sectors and operation scales makes it a very valuable tool for business involvement.

Available from: www.allianceforwaterstewardship.org/

4.6 Tools dealing with institutional and governance factors

Community-based governance of freshwater resources in Southern Africa (Pollard and Cousins 2008):
This report, aimed primarily at researchers and policy makers, explores issues of natural resource management of wetlands in communal areas. It sets out the institutional confusion brought about by multiple legal systems – customary and statutory – described as legal pluralism. The report develops a conceptual framework for case-study analysis and uses this framework to review community governance of water resources in South Africa, Mozambique, Zimbabwe and Zambia. It concludes by suggesting appropriate governance arrangements for water resource management in communal areas of South Africa.

RLA recognizes that a key foundation for water resources stewardship is a sound governance system, but this is complicated by the legal pluralism described above and by many problems with implementation. Thus, guidance is required to understand and address some of the problems, and the framework applied by Pollard and Cousins (2008) has relevance, particularly to areas under communal tenure, but also to areas under private tenure.

Available from: http://www.wrc.org.za/pages/KnowledgeHub.aspx

Guidelines: Developing and using a Wise Use approach within the context of Working for Wetlands (Pollard and Sefatsa 2014) 1:
The wise use guidelines are tailored especially for wetlands which are to be rehabilitated but are likely to be much more broadly applicable. They begin by providing concepts and guiding principles, and then describe a two stage structured process. Stage 1 is a rapid assessment of about three days which sets the scene by asking what is known about the site from a socio-economic, environmental and political perspective and whether or not the understanding is sufficiently deep and coherent to allow for the development of a shared vision (within the community and between the community/ land owner and service provider) and if each shows potential for adaptive capacity. This is done through a process of self-reflection rather than as an external assessment. Stage 2 is a much longer commitment over the duration of rehabilitation which is designed to address issues raised in Stage 1. Several steps are suggested for Stage 2 including, amongst others: identify a vision and objectives; work with stakeholders to understand key features related to wetland use/ beneficiation; identify gaps in understanding - especially in terms of indicators to track wetland health and the associated benefits; design a participatory process to improve the understanding; undertake collective analysis of results and implications; and select key indicators for monitoring beneficiation from wetland health. Stage 2 further involves providing support for sustainable wetland use practices, especially concerning agricultural practices and livestock grazing through engaging farmers in collaboratively identifying problems and solutions and supporting wetland users in implementing solutions and undertaking a self-assessment of their land-use practices, adapting and, if necessary, providing further support. Line spacing

The guidelines interpret wise use as the sustainable use of wetlands through good stewardship and integrated land and water use practices that promote healthy wetlands so as to continue to sustain ecosystem services supply and human livelihoods. All of these elements are contained with RLA, and therefore the guidelines clearly have potentially wide-ranging relevance to RLA

Available from: The guideline is still in draft form and is available from David Lindley (dlindley@wwf.org.za) on request.

Wetlands and Well-being: Getting more out of South Africa's wetlands (Hay et al. 2014):
This handbook introduces the importance of wetlands to the livelihoods of rural South Africans and provides a general context relating how history has brought us to the present and summarising the key findings of research conducted over the last fifteen years. It then provides a user's perspective on wetlands and well-being focusing on practical examples of how we might get more out of wetlands. Next it describes the main attributes of a wetland social-ecological system explains the adaptive process that facilitates local-level wetland management that might be adopted and the key principles informing this process. In engaging this process it lists some key questions that participants could ask and answer to improve overall understanding of the system and its dynamics and to promote a relationship between people and wetlands which is to the benefit of both constituents. Finally it provides four different cases and a guide to detailed literature and resource material that might be useful for specific applications. The handbook builds on the tool developed by Bowd et al. (2012a and b) for estuaries, which can be referred to for more detail.

This handbook has a potentially useful contribution to make to RLA because its focus is building an holistic understanding social-ecological systems, which is one of the key components of RLA.

Available from: http://www.wrc.org.za/pages/KnowledgeHub.aspx

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WET-Legal: Wetland rehabilitation and the law in South Africa (Armstrong 2009):

WET-Legal presents South African legislation that is relevant to wetland rehabilitation, including the Conservation of Agricultural Resources Act (CARA), National Environmental Management Act (NEMA), and National Water Act (NWA), as well as relevant international agreements such as the Ramsar Convention on Wetlands. WET-Legal lists the environmental impacts potentially associated with typical wetland interventions and the legislative provisions that apply to each of these impacts. It also covers laws compelling rehabilitation and the legal responsibilities of different parties involved in rehabilitation.

RLA recognizes that a key foundation for water resources stewardship is governance, which includes legislation. Several different acts have relevance to managing, rehabilitating and regulating the use of wetlands, rivers and other water resources, and clear guidance is therefore required to assist non-experts in determining which pieces of legislation are relevant to which particular land-use activities. Thus, WET-Legal has a very useful contribution to make, although restricted to rehabilitation activities rather than production activities.

Available from: http://www.wrc.org.za/pages/KnowledgeHub.aspx

In the following section, WET-EcoServices and WET-Health, two of the tools reviewed above to which MWP had an important contribution and which have been widely applied in South Africa and beyond, are examined in more detail.

5 RESULTS OF THE FOCUSSED ASSESSMENT OF WET-ECOSERVICES AND WET-HEALTH

5.1 Contributions of the tools

Application for building knowledge and competency

WET-Health and WET-EcoServices are an important part of the "Tools for wetland assessment" course which has been presented by Rhodes University since 2009, and has been run a total of seven times since then, involving about 150 participants. The participants are mainly consultants (about 50 %) and government officials (about 40 %), with the remainder from Working for Wetlands (a government-led programme focussed on wetland rehabilitation), universities, NGO's and water utilities. Two forms of certification are provided – one for attendance and the other for "competence". For the certificate of competence, participants are required to obtain a mark above 70 % for their assignment that should take 5 working days, with approximately half of the participants receiving a certificate of competence. Over the last six years the "Tools for wetland assessment" course has also been run for approximately 60 honours students, who are required to undertake the assignment (Ellery W 2014. Pers comm. Rhodes University, Grahamstown).

Many of the participants arrive with rather set general assumptions about wetlands and the benefits which wetlands supply, but leave better appreciating more of the complexities and depth of how wetlands function and how the services supplied by wetlands may vary greatly from one wetland to the next. WET-Health and WET-EcoSerives, together with WET-Origins, have played an important role in building this understanding (Ellery W 2014. Pers comm. Rhodes University, Grahamstown). WET-Health in particular is used to assist participants to structure the way they think about wetlands by focusing on hydrology, geomorphology and vegetation, and how they interact to structure wetlands.

WET-EcoServices and WET-Health have provided useful frameworks for developing the understanding of University of KwaZulu-Natal honours and masters students, which have included the following students and theses:

- Nkosi M 2005. The effect of wetland rehabilitation on wetland ecosystem goods and services: an investigation of two South African case studies. MSc mini-thesis, University of KwaZulu-Natal, Pietermaritzburg

- Pillay D 2007. The Mpophomeni wetland: health, use and perceptions. Honours thesis, University of KwaZulu-Natal, Pietermaritzburg

- Botes W 2008. Measuring the success of individual wetland rehabilitation projects in South Africa. MSc thesis, University of KwaZulu-Natal, Durban

- Bodman L 2011. An investigation on the variation of scores from users of the wet-health tool. Honours thesis, University of KwaZulu-Natal, Pietermaritzburg

- Ramburran E 2013. The Utilisation of the WET-Health and WET-EcoServices Tools in the Application of Wetland Decision Making. MSc thesis, University of KwaZulu-Natal, Durban

Application for rehabilitation planning within Working for Wetlands

In the 12 years since its inception, Working for Wetlands has invested 530 million Rand in the rehabilitation of 906 wetlands, thereby improving or securing the health of more than 70,000 hectares of wetland area (http://wetlands.sanbi.org/index.php). From 2005, and therefore over the last 9 years, the early and modified versions of WET-Health and WET-EcoServices were used to plan rehabilitation for almost all of the identified wetlands (Cowden C 2014. Ground Truth, Hilton, KwaZulu-Natal). Given that the annual Working for Wetlands budget has increased progressively over much of the 12 year period it can be safely stated that WET-Health and WET-EcoServices have contributed to planning rehabilitation costing more than 300 million Rand in the rehabilitation of more than 500 wetlands, thereby improving or securing the health of more than 40,000 hectares of wetland area. Unfortunately, however, to date Working for Wetlands have undertaken almost no evaluation of the ecological outcomes of their rehabilitation, whether using these tools or any other means, but this topic is being addressed in a recently initiated Water Research Commission research project.

Use in conducting EIAs and State of the Environment reports

As seen in Section 5.2, both WET-Health and WET-EcoServices have been used fairly widely in South Africa to assist in carrying out EIAs for proposed developments potentially impacting upon wetlands. However, it is difficult to gauge the full extent of this application.

WET-Health was used as the primary basis for conducting a State of the Environment Reports for KwaZulu-Natal's 24 priority wetlands (Macfarlane et al. 2012) and for 13 of Mondi's priority wetlands (Walters et al. 2011).

Application internationally

WET-Health and WET-EcoServices were designed specifically for South Africa, but they are considered to have relevance to other countries, particularly in Africa. Although they have not been actively promoted outside of South Africa, in a Special Issue of the journal "Environmental Science and Policy", December 2013, on "Management of Wetlands in River Basins: the WETwin project" several papers were published where WET-EcoServices was applied at sites across three different continents (Africa, Europe and South America) and six different countries (Mali, Uganda, South Africa, Austria, Hungary and Ecuador) (Arias-Hidalgo et al. 2013; Cools et al. 2013; Johnston 2013; Namaalwa et al. 2013; Rebelo et al. 2013). WET-Health was also applied at several of the same sites. Another application of WET-Health and WET-EcoServices outside of South Afirca were their use in the assessment of ecological sustainability of use of some case study wetlands in Malawi and Zambia (Kotze 2011b and 2013). A modified version of WET-EcoServices was also applied by Sullivan et al. (2008) in Lesotho.

Contribution towards the development of other tools

WET-SustainableUse (Kotze 2010) builds closely on the structure and content of WET-Health and was designed to be used as a "plug-in" to WET-Health, and covers with some specific aspects which are not included in WET-Health. In addition, the Wetlands and Livelihoods Decision Support system (Kotze 2014) draws extensively from WET-EcoServices but adds some missing dimensions which were not covered by WET-EcoServices (see Section 4). For those already using WET-EcoServices, the DSS is not intended to replace WET-EcoServices, but rather to add new elements to its application and to help place it in the context of the overall social-ecological system.

WET-EcoServices also made an important contribution to the method for determining the Ecological Importance and Sensitivity of wetlands (Rountree and Kotze 2013) but it is still too recently developed to gauge its application.

5.2 Results of the questionnaire survey

A total of 15 respondents completed the questionnaire given in Appendix A for users of WET-EcoServices and WET-Health. All 15 respondents had applied WET-Health and 13 of them had also applied WET-EcoServices, but one of the respondents indicated that they had applied the tools insufficiently to be able to score their effectiveness. The survey included five respondents from government departments, seven from consultancies and three from NGOs. The respondents from government departments and NGOs tended to have used the two tools on training courses as a means of building their understanding, with sporadic use thereafter for general assessments or research. However, the respondents from consultancies had generally used the tools more frequently and applied them for a greater variety of specific purposes, as described below.

WET-EcoServices

WET-EcoServices was used for a range of applications, including the following:

- To identify key wetlands for enhancing ecosystem provision, e.g. as part of catchment planning
- For rehabilitation planning to establish potential gains which would be achieved in terms of ecosystem services provision
- For building an understanding of how wetlands work and contribute to society.
- As part of planning for offsets to identify services which will be most heavily impacted by developments
- As part of the wetland assessment for EIAs (Environmental Impact Assessments)

Most respondents scored WET-EcoServices as effective (Figure 5.1) with the following strengths listed by the respondents:

- Works well to rapidly highlight key ecosystem services provided at a particular site.
- Leads the practitioner through the assessment quite well, and is relatively accessible to non-specialists.
- Captures key attributes that are important to consider when assessing the delivery of an ecosystem service, thereby reducing reliance on subjective judgements and increasing accessibility to non-specialists

- Useful for systematically evaluating the relative importance of different wetlands in terms of ecosystem services provision.

- Great too to help build understanding about the critical attributes of a wetland affecting its importance in terms of service provision.

- The desktop assessment (Level 1 assessment) is “short and sweet” which makes it attractive.

- The automated calculation of importance score for each ecosystem service based on the attribute scores makes the system easy to use.

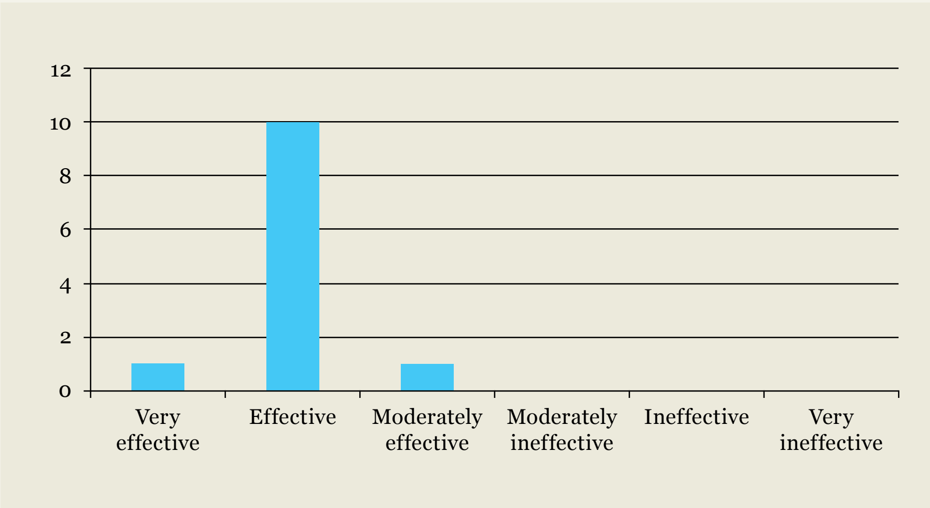
- The confidence scoring allows users to account for uncertainty and lack of full details/information which makes the tool realistic.

- Scores are relatively easy to interpret and relate to management requirements.

- The two phased design (Level 1 and Level 2) allows for flexibility that makes the tool relevant for meeting various objectives.

- The tool incorporates the social value aspect of wetland use which allows for more meaningful, holistic wetland assessment, and can be useful to bring different influential sectors together to give consideration to wetlands when approving or objecting to development applications. By including direct benefits allows for inclusion of people and their relationship with their surrounding environment.

Figure 5.1: Effectiveness rating from the 12 respondents who have applied WET-EcoServices



Respondents reported the following aspects of WET-EcoServices which did not work well:

Issues relating to wetland size and quantifying service provision

- Although the tool highlights size as an issue which the operator needs to consider along with the importance score, it does not integrate size into an overall importance score. Unfortunately, certain applications, e.g. EIAs and offsets require that this be done so as to prioritise wetlands in relation to each other in terms of impacts or losses. Without taking size into account in the score, big systems that score (independently of area) intermediately may be overlooked for higher scoring smaller ones.

- Failure to provide quantitative measures of ecosystem service provision, e.g. using an approach similar to that of hectare equivalents derived from WET-Health scores. This issue is directly linked to the above issue.

- When using the scores from a WET-EcoServies assessment in an EIA or offsets assessment, the scores need a lot of additional expert interpretation (e.g. taking into account area) which relates in part to the above issue.

Issues relating to separation of supply and demand

- For provisioning services, WET-EcoServices does not allow for calculating a separate score for supply (effectiveness) and demand (opportunity). This is a limitation for several applications of the tool, e.g. for exploring different development/land-use options.

- In some circumstances, scores tended to be a little higher than expected based of professional experience. This was often due to high opportunity scores. This issue is linked in part with the above issue.

General issues relating to ease of use

- The tool does not generate an overall importance score by integrating the individual scores for all the individual ecosystem services assessed. Guidance for generating such a score needs to be provided for those applications where an overall score is required.

- Some of the exceptions and nuances which are pointed out in the manual are not given in the spreadsheet, and thus if the operator is not referring regularly to the manual they might overlook these.

- Some of the nuances (e.g. surface roughness changing over the season) could be elaborated upon a bit more in the manual.

- The questions that relate back to the WET-Health assessment framework should be more explicitly highlighted in order to ensure that the answers are carried through the assessments.

- A few of the attribute questions (e.g. relating to the 'Level of poverty in the area') need to be better explained so that they are less open to interpretation.

Other general issues

- Some attributes (e.g. direct evidence of sediment deposition) appear to be afforded too much prominence in determining the score for the ecosystem service. In the case of sediment trapping, the wetland may be accumulating sediment from alteration in the catchment run-off/sediment regimes but coping with the sediment well so as to not show noticeable visual signs of it.

- Some of the attribute information (e.g. soil forms, which define the erosion hazard/ erodibility of the soil) may not be readily available to some users of the tool.

- If an assessment needs to be made very rapidly (in order to cover many wetlands) assessments can be too time consuming. It would be good to include a single qualitative rating (rather than scoring all of the individual attributes), i.e. something in between a Level 1 (desktop) and Level 2.

WET-Health

WET-Health was used for a diverse range of applications, including the following:

- General assessments of wetlands

- Wetland assessments for EIAs

- Rehabilitation planning to identify important problems requiring rehabilitation and to establish potential gains which would be achieved in terms of ecological condition (which can be expressed in terms of hectare equivalents and used to help assess returns on investment).

- Building an understanding of how wetlands work.

- As part of planning for offsets to identify hectare equivalents required and supplied

- Assessments of wetlands for State of the Environment reporting

- For assessing the Present Ecological State in Ecological Reserve Determination studies

Most respondents scored it as effective (Figure 5.2) with the following strengths were listed by the respondents:

- Systematically working through the different sub-components in the tool forces one to consider the different aspects of wetland health, some of which you may have overlooked if you had not been following the system

- Carrying out a WET-Health assessment helps one understand better how wetlands function and how these functions may potentially be impacted upon by different uses.

- Provides a useful means of (semi-)quantitatively evaluating ecological outcomes of different interventions, including developments and rehabilitation.

- The anticipated trajectory of change is a useful dimension to add to the score of current state, which gives a more complete picture of the health of the wetland.

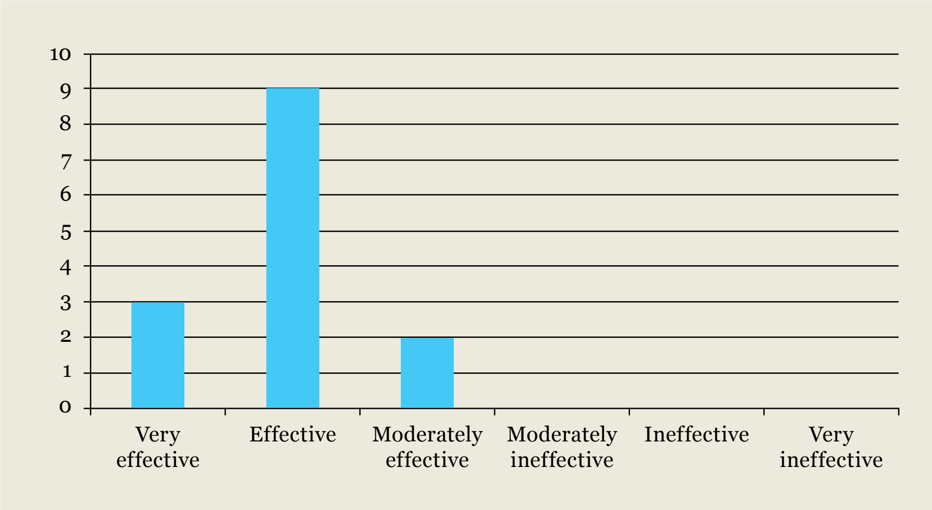
- The system is fairly user friendly provided that you have had close guidance the first couple of times from someone who is familiar with the tool.

- The default scores (included in the vegetation component) are useful, especially for a new user without enough experience to manually weight impacts.

- The descriptions and diagrammes of the hydrogeomorphic types were very effective.

The automated components of the spreadsheets were very useful.

Figure 5.2: Effectiveness rating from the 14 respondents who have applied WET-Health



Aspects of WET-Health which did not work well included the following:

General issues relating to expertise required to apply the tool

- It requires a good depth of understanding to apply, particularly for scoring certain attributes such as projected trajectory of change, which makes it dangerous for anyone who is not a wetland specialist to apply the tool. One respondent referred to consultants without any training who are misapplying the tool.

- Some important aspects of the assessment (particularly those relating to the natural reference state) are potentially open to a lot of personal interpretation. This issue is aggravated by lack of training/experience/knowledge.

- Different assessors can arrive at different results for the same wetland depending on their particular knowledge.

- If you have not applied the tool for a long time you lose your familiarity with the method, and so when you do eventually apply it, you need to learn a lot again from scratch.

- It can be quite time-consuming to carry out a WET-Health assessment, although this time is probably necessary, but can be a key issue when many wetlands have to be assessed at a broad-scale.

Other general issues

- The tool needs a water quality component, as this is an important component of a wetland’s health.

- Some impacts (e.g. relating to fire and to a variety of urban impacts) are not explicitly covered by WET-Health.

- The tool is weaker when it comes to highly transformed systems especially in urban settings, with infilling, altered water inputs.

- Having to break a wetland up into hydrogeomorphic units for the assessment works well when you are assessing one or a few wetlands, however, when you are assessing a large number of wetland across the landscape, this can prove a tedious and time-consuming task.

- The tool is lacking explicit guidance for describing and documenting the wetland’s reference state against which the assessment is being made.

- More emphasis should be placed on accurate mapping of disturbance units because the size of the respective disturbance units has an important bearing on the final scores.

- For certain attributes (e.g. area of hardened surfaces) the class intervals are too wide (e.g. 25 – 50% or 51-75%).

- The spreadsheets are cumbersome to navigate through as they include several sheets and involve flipping back and forth to look-up tables, and there are also some calculation errors in the spreadsheets.

- Lack of a diversity of case example wetlands which have been assessed with WET-Health, which can serve as useful reference points, e.g. as "benchmarks" for inexperienced wetland users to refer to.

Specific issues with the particular modules

- The catchment hydrology section needs to better account for pan systems, particularly those associated with coastal aquifers.

- The hydrology module does not adequately account for the extreme impact of a large open cast mine in the wetland's catchment.

- Some of the information requested (e.g. whether upstream dams have specific allowance for releasing low flows) would generally not be available.

- Level of increased flood peaks is assessed very coarsely based primarily on the extent of hardened surfaces, but this could be refined by considering run-off coefficients for a suite of land uses as a deviation from reference state of vegetation cover in the catchment.

- Depression wetlands are not accounted for well in the geomorphology component, e.g. based on the fact that sediments are not transported out of the system by water.

- In the Geomorphology section, the impacts of infilling need to be considered for all hydrogeomorphic units and not just certain ones.

- Some of the sub-components of geomorphology are only assessed for floodplains (e.g. impacts of dams trapping sediment) but would appear to be potentially very relevant to some other hydrogeomorphic types (notably channelled valley bottoms).

- For the vegetation component there is too great a focus on species composition and insufficient attention given to functional type.

5.3 Discussion

The results reported in Section 5.2 are briefly discussed in this section, also referring to key findings of other reports such as Eggers and Cowden (2013) and Ollis and Malan (2014). The focus of the discussion is on the two tools to which Mondi Wetlands Programme have most actively contributed, namely WET-EcoServices and WET-Health. To start, it must be emphasized that this is not an exhaustive review and evaluation of the two tools, but it is hoped this it will have highlighted most of the key issues, thereby informing future refinements of the tools. It is over five years since both tools were developed, with no subsequent refinement/s, and therefore it is to be expected that areas for improvement would have been identified.

In South Africa, assessments of wetland ecological condition (health) and the provision of ecosystem services are frequently required (e.g. for ecological reserve determinations, EIAs, and wetland management and rehabilitation planning). However, existing detailed studies to which reference can be made are scarce and the resources available to carry out detailed assessments are usually very limited. Thus, the need for rapid assessments is great. In the past, there was no consistent approach for carrying out such assessments. WET-EcoServices and WET-Health provide structured approaches for conducting such assessments in the absence of detailed studies of reference wetlands.

Section 5.1 and 5.2 show that WET-Health and WET-Ecoservices have been used in a diverse range of applications. In terms of informing on-the-ground decision making, the greatest contribution has probably been in planning wetland rehabilitation interventions within the Working for Wetlands Programme. The tools have also contributed to the training of many professionals, providing bases for building their functional understanding of wetlands. Furthermore the tools have been applied widely for undertaking wetland assessments within EIAs and to assist in assessing offset requirements for certain developments. The tools have also been piloted in certain new applications, notably for State of the Environment Reporting and the outcomes of these assessments indicate promising areas for wider application. Finally it is encouraging to see that the tools have begun to be applied outside of South Africa.

Both tools were generally considered to be effective by users of the tools who responded to the survey. However, there were nonetheless several issues identified which need to be addressed, and those considered to be of particular importance are briefly discussed below and practical suggestions are proposed in Section 6 for addressing these issues.

WET-EcoSErvices has a lower requirement in terms of technical expertise than WET-Health, and the key issues raised in Section 5.2 and by Egggers and Cowden (2013) relate in particular to the tool being too confined in its scope. Foremost amongst these was the fact that the tool does not allow size of wetland to be integrated into the importance score of the wetland, instead requiring that the user carry this out as a separate exercise. The second key issue related to the insufficient attention given by WET-EcoServices to explicitly dealing with (and separately scoring) both the supply and the demand for ecosystem services.

Probably the most prominent issue raised by several users of WET-Health was the high level of expertise/knowledge required for applying the tool, and this issue is not alleviated by WET-Health having a more rapid Level 1 version available.

Although Level 1 is less laborious to conduct than a standard Level 2 assessment, it is, in fact, more reliant on expert opinion than Level 2. For example in Level 2, various parameters (e.g. drain density, depth and orientation) are used to calculate an impact-of-drainage score based on a prescribed formula, whereas in Level 1 an impact-of-drainage score is assigned based on best professional judgement. Wetland IHI (DWAF 2007) which is pitched at a similar level of detail to WET-Health Level 1, is also reliant to a similar degree on best professional judgement. Ollis et al. (2014) report that in a formal test of the robustness of WET-Health level 1 and Wetland IHI (DWAF 2007) independent operators scored relatively closely for systems which had not been highly transformed, but some widely divergent scores were assigned to wetlands subject to high levels of transformation. In a formal test of the robustness of WET-Health level 2 by Bodman (2011) independent operators scored a closer than in the study of Ollis et al. (2014). Nonetheless, there was still some divergence, and there is clearly a need for refinements to improve the robustness and repeatability of the method.

Other important issues include: (1) the length of time required to conduct an assessment, which restricts the application of WET-Health for the assessment of many wetlands across wide areas of a landscape or catchment; (2) insufficient coverage of certain impacts, notably those relating to water quality; and (3) inadequate attention given to explicitly describing the reference state of the wetland.

For both WET-EcoServices and Wet-Health there is a lack of case example wetlands which have been assessed with the tools and described in detail so as to provide users of the tools, especially less experienced users, with points of reference against which they can benchmark their own assessments. Furthermore, there is also a lack of reference sites for which biological and physico-chemical parameters have been described in detail and for which Fennesy et al. (2007) recommend should be used to validate and improve rapid assessment methods. However, it is encouraging to note that since the two tools were published, there have been comprehensive descriptions of biological and physico-chemical parameters undertaken at a few wetlands, e.g. Riddell et al. (2010; 2012; 2013). Thus, we are currently in a much better position to begin validating tools such as WET-Health and Wet-EcoServices than we were five years ago.

6 RECOMMENDATIONS FOR REFINEMENTS TO THE TOOLS

6.1 WET-EcoServices

Inclusion of wetland size into an importance score

The overwhelming need indicated by respondents in terms of refining WET-EcoServices was for inclusion of wetland size into an importance score. This could be done using the approach of Kotze (2014) whereby the importance score derived from WET-Health as it stands, which is independent of wetland size, is converted to a scale of 0 to 1 and multiplied by the size of the wetland unit to give "Hectare-equivalents of ecosystem service supply". The underlying assumption here is that all other factors being equal, the larger a wetland, the greater will be the delivery of a given service. It is recognized, however, that not all ecosystem services are related to wetland size to the same degree. Therefore it is anticipated that the approach can be refined through application and testing.

Separate scores for supply and demand of provisioning services

The next highest priority for refining WET-EcoServices is to include the facility to generate separate scores for supply and demand of provisioning services. The approaches used by Sullivan et al. (2008) and Kotze (2014) could potentially be used. However, it is recommended that the individual attributes used in WET-EcoServices first be reviewed and refined (see the following issue below).

Reviewing and refining the attributes used for deriving the scores

There is also a need to re-examine the attributes used for deriving the scores and refine these in the light of the enhanced understanding which has developed over the last five years since the tool was developed. It is recommended that WET-EcoServices be applied to see sites which have been comprehensively assessed, e.g. the Craigieburn wetland (see Pollard et al. 2009 and Riddell et al. 2010, 2012 and 2013). In order to build understanding of the link between ecological condition (health) and the delivery of ecosystem services it is recommended that both of these aspects be assessed together at these sites.

6.2 WET-Health

Addressing the expertise/knowledge required to apply WET-Health

The issue of the high level of expertise/knowledge required to apply WET-Health should be addressed through amplifying the unclear aspects of the tool (see Section 5.2) and by building up a "library" of well documented case example wetlands which have been assessed with the tool and can assist inexperienced users in benchmarking their assessments. Training and mentorship are also critical, and this should include the formal review of assessment reports.

Another possible avenue for addressing this issue lies in the approach used in the WET-Health level 1 vegetation component where default scores have been assigned to each of a wide range of disturbance types, which serve to guide the assessor. It is suggested that this same approach could be extended to the hydrology and geomorphology components to make them more closely aligned with the vegetation component. The first step in following this approach would be to generate a list of disturbance/land-use types to which typical impact scores are assigned based on expert judgement. These scores would be peer-reviewed in an attempt to make them as defensible as possible. Next, good photos and diagrammes would need to be assembled to assist in identifying these disturbance types. This is similar in approach to the user-friendly photo guide developed by Graham and Louw (2009) for rivers (including riparian areas). Once the default scores have been finalized and photographs selected to help identify the types, the system would be available for use. The primary task of the operator would be to identify the different disturbance types present in a wetland and map these as accurately as possible. The operator could engage in adjusting the pre-assigned scores based on specific knowledge of the site (and explaining the basis for this adjustment), but this would not be an essential requirement for applying the tool.

Improving the ease of application of WET-Health across many wetlands in a catchment or landscape

Another key issue relates to the limitations of the tool when many wetlands need to be assessed at a landscape or sub-catchment scale. WET-Health Level 1 and 2 and Wetland IHI (DWAF 2007) are all essentially field-based techniques and are not designed specifically for a large-scale, coarse assessment undertaken primarily at a desktop-based, e.g. across an entire sub-catchment. It is suggested that the approach of assigning default scores for hydrology, geomorphology and vegetation to disturbance types (described above) would also assist greatly in undertaking these broad-scale assessments. But again it is anticipated that the approach will need to be refined through application and testing, particularly given that the assumptions which this approach makes are likely to be more general than in WET-Health as it stands. It is important to emphasize that the default-score approach is not seen as an alternative to the current WET-Health tool but rather a means of applying WET-Health at a broad, coarse scale where resources are limited for conducting field-based assessments of individual wetlands.

Including a component dealing with water quality impacts on wetlands

Water quality has always been recognized as a dimension not properly addressed by WET-Health. However, rather than developing this component for inclusion within WET-Health, is recommended that the recently developed guidelines for assessing water quality impacts on wetlands by Malan et al. (3013) be used. This method is described briefly in Section 4.2.

Addressing specific key impacts not well covered by the existing system

WET-Health, if used in combination with the method of Malan et al. (3013), covers a very wide diversity of impacts on wetlands. Nevertheless, some impacts were noted which are not well accounted for, e.g. the geomorphology component of WET-Health does not take any account of sheet erosion in the wetland. In an agricultural setting, it is anticipated that WET-SustainableUse could be used, at least in the interim, to fill this gap. However, in a urban setting no obvious supplementary tools appear to be available, and the key recommendation is to build up a diversity of case examples encompassing the full range of impacts on wetlands typically associated with urban areas in particular.

Comprehensive refinement of the individual components, hydrology, geomorphology and vegetation

Given the results reported in Section 5.2, it is anticipated that comprehensive revisions will be required for the three components of WET-Health, particularly its geomorphology component and the hydrology component dealing with impacts from the upstream catchment. This will need to include, amongst other refinements, incorporating guidance for assessing which contexts and hydrogeomorphic settings (in addition to floodplains) might be significantly impacted upon by upstream dams starving the hydrogeomorphic unit of sediment and by infilling in the wetland. It would also include refinements to the sub-component dealing with the effects of land-use in the wetland's upstream catchment on runoff intensity to the wetland. However, before these revisions are undertaken it is recommended that wetland sites with existing detailed investigations of wetland functioning, e.g. Riddell et al. (2010, 2012 and 2013), be used in the field validation of the tool.

Explicitly describing the reference state of the wetland

More explicit guidance is required to assist the user in describing the reference state of the wetland. In the short term, at least, rather than developing this component for inclusion within WET-Health, is recommended that the recently developed guidelines of Ollis and Malan (2014) be used.

6.3 The link between refinement of the tools and the training of practitioners

The tremendous need for training of practitioners was highlighted by Eggers and Cowden (2013) and Ollis and Malan (2014), as well as in Section 5. To quote one of the respondents from the questionnaire survey reported in Section 5.2: "Training, training, training." Therefore it is critical that refinement of WET-EcoServices, WET-Health and any other relevant tools be closely aligned with the training of practitioners. In fact, fertile opportunities for synergies between refining the tools and training practitioners are likely to exist. Firstly, the training events/exercises represent opportunities for identifying specific refinements required (e.g. identifying where most participants misinterpret a particular guideline or in identifying inadequacies/gaps in the expert knowledge base of the tools). Secondly, once the refinements have been undertaken (e.g. specific guidelines which were confusing are better clarified or the expert knowledge base of the tool strengthened to fill identified gaps) then an improvement is likely in the application of the tools by the participants and in their competency in carrying out wetland assessments generally.

Training events provide potential opportunities for formally testing the repeatability of the tools. Once participants are reasonably familiar with a tool then they could all independently apply the tool to the same case wetland and the results of the application compared statistically to determine the repeatability of the methods, as was carried out by Bodman (2011). The greater the diversity of different cases and situations included in such tests, the greater will be the opportunities for exposing deficiencies in the tool, which could then be addressed when refining the tool.

Mentoring, e.g. involving an experienced practitioner closely reviewing the assessment reports of a less experienced practitioner, provide useful opportunities for gaining detailed qualitative insights into application of the tools, which could also inform refinement of the tools.

However, it is important to recognize that even after many refinements, some key limitations of a tool, determined partly by the scope of the tool, will always remain. Close alignment of the training and tool-refinement processes will help to more fully expose and clarify these limitations, thereby allowing the refined tools to include more explicit guidelines and "warnings" for future users of the tools.

Refinement of the tools also has relevance to the issue of accreditation of practitioners. Although full agreement has yet to be obtained on how accreditation will be implemented, there seems to be growing consensus that some form of accreditation of wetland practitioners is required. Thus, if practitioners are to be formally accredited on their application of a tool then this adds further importance to addressing inadequacies in the tools through well-informed refinements.

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APPENDIX A: A BRIEF QUESTIONNAIRE TO SOLICIT FEEDBACK FROM USERS OF WET-ECOSERVICES AND WET-HEALTH

WET-EcoServices

Please describe the situations for which you have used WET-EcoServices.

How effective did you find it?
- Very effective
- Effective
- Moderately effective
- Moderately ineffective
- Ineffective
- Very ineffective

If any, what were some of the things in WET-EcoServices that worked well and why?

If any, what were some of the things in WET-EcoServices that did not work well and why?

Elaborate further on any key problems which you encountered with WET-EcoServices and any suggestions you have for improving the tool.

WET-Health

Please describe the situations for which you have used WET- Health.

How effective did you find it?
- Very effective
- Effective
- Moderately effective
- Moderately ineffective
- Ineffective
- Very ineffective

If any, what were some of the things in WET- Health that worked well and why?

If any, what were some of the things in WET- Health that did not work well and why?

Elaborate further on any key problems which you encountered with WET- Health and any suggestions you have for improving the tool.

WWF's work in the uMgeni River Catchment

1991

The year that the very successful WWF Mondi Wetlands Programme was established

5MIL

Number of people that reside within the Greater uMngeni River Catchment in KwaZulu Natal, South Africa

6

Number of sub-catchments where WWF and its partners are piloting and testing the Resilient Landscape Approach and strengthening water stewardship

495mm

South Africa's average rainfall per annum

20%

Total estimated gross national product of the country generated within the Greater uMngeni River Catchment

Why we are here

To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

www.wwf.org.za