NEPAD SOUTHERN AFRICAN WATER CENTRES OF EXCELLENCE LEARNING PROGRAMME ON SECTOR WIDE APPROACH – KNOWLEDGE MANAGEMENT STRATEGY IN THE SADC REGION

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List of acronyms

AWIRU	African Water Issues Research Unit
CGIAR	Consultative Group on International Agricultural Research
CGVLibrary	Consultative Group on International Agricultural Research Virtual Library
COE	Centre of Excellence
CM	Content Management
CMS	Content Management System
DWAE	Department of Water Affairs and the Environment
DWAF	Department of Water Affairs and Forestry
EUROSTAT	Directorate General of the European Commission
GIS	Geographical Information System
GWP	Global Water Partnership
IBNET	International benchmarking network for water and sanitation
ICT	Information and communication technologies
IT	Information technology
ITU	International Telecommunications Union
KAM	Key asset management
KEI	Knowledge Economy Index
KM	Knowledge Management
MIS	Management Information System
KMS	Knowledge Management System
NRI	Networked Readiness Index
OECD	Organisation for Economic Co-operation and Development
PC	Personal Computer
SADC	Southern Africa Development Community
SANWATCE	Southern African Water Centres of Excellence
SWAP	Sector Wide Approach
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNECLAC	United Nations Economic Commission for Latin America and the Caribbean
UNECA	United National Economic Commission for Africa
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific and Cultural Organization
WARFSA	Water Research Fund for Southern Africa
WDM	Water Demand Management
WRC	Water Research Commission

Executive Summary

BACKGROUND

The UN Conference on Water message to the world that resounded from Mar del Plata in 1977 was that water is a finite resource. It was followed through with the announcement that there would be a Decade, 1981 – 1990, devoted to International Drinking Water Supply and Sanitation. The call is for strong institutions to drive policy, regulation, use, protection, management and control of water. resources Within this context what is required is not simply the dissemination of information about water, but the development of skills to generate, manage, disseminate and use information so that it improves water resources management. A global Content Management System (CMS) is a fundamental building block for this purpose. The water sector is a knowledge-intensive sector and a CMS allows for the organization, storage and retrieval of data for a large number of people. This is especially relevant within the context of the NEPAD Southern African Water Centres of Excellence, the frame for this study. The information age has spurred on an interest in CMS and these are no longer a 'nice to have' but a 'must have'.

CONTENT AND KNOWLEDGE MANAGEMENT ISSUES

The CMS produces a very specific, goal-directed repository – the intent being to contribute to solutions of specific problems related to the water sector. There is an ethical issue of knowledge production, linked with the way in which content is codified, stored and managed, accessed and disseminated.

The emphasis in the generation of content is on process. An interactive and dynamic relationship exists between innovation and the practical way that ideas transform into action and goods and services that improve the life of society and nature. This is because the systems, together with the community of practitioners who use it, together create a self-regulating environment. If the ideas are too technical or 'scientific' they will have no appeal to the users and the community will reject them or rate as low priority for them – the content might be stored but it will not be used. The community of users is the fabricator as well as the mediator of content for practical purposes.

Content management is user driven, interactive and demand driven. This interactive process of engagement with a CMS is key to building capacity, an active process. An essential component of the desired CMS is the dynamic nature of the system with its emphasis on the interrelationship of content within the system and between the system and sector users. The agility and adaptive capacity of society depends on how the knowledge at their disposal is exchanged, reconsidered, abandoned and renewed. A robust content management system will be able to store data that is useful for now and for the future. The data ranges from simple verbal protocol, stories about the lives of people in the field and experiences of practioners as they interact with everyday research experiences at the coalface, lessons handed down orally from generation to generation, to highly technical and advanced content that is stored and accessed.

Paradigms often create difficulty because they are commonly accepted as one perspective based fact and taken for granted. The person operating within that paradigm is sure that her/his way is the only way to see or to do. The advantage of a dynamic CMS is that a common way of doing things is challenged by the users themselves who interrogate debate and add new content to the system.

KNOWLEDGE AND ETHICS

With the urgency of problems that face the globe in the 21st Century, unless there is uptake of science through the process of dissent, debate and discussion, data, ideas and innovation might just as well not be there. The collection of data, the databank or database, is a physical repository of varied views of the real world that represent our knowledge at one point in time. Bias in individual items of knowledge can be an advantage, adding thought provoking value to the repository within which bias resides. Knowledge at any particular moment is partial. A content management system is only as good as the content that is made available on it. The existence of various biases on any one topic is an advantage insofar as it fosters investigative thinking - the root of problem-solving.

Management of a CMS requires a high level of ethical wisdom. If submission of material were entirely open, it would be possible for individuals or organisations to use the site to manipulate public opinion, garnering public support for a cause that is destructive for our

environment in general and for water resources in particular. A website of this nature could also become glutted with to-and-fro slang matches between opposing parties on a particular water-related issue. It would need to accommodate for a space in which such word-wars could take place, but this component of the CMS would be identified clearly as the domain of opinion rather than fact, having boundaries that protect the actual database from contamination. There are also security threats to the integrity of the data through hackers and firewalls. Security measures are not immune to these attacks. It is within the ecosystemic ethic that we see the true value of CM, its potential for simplifying complexity and facilitating interconnections. Within this same ethic, not one aspect of a system stands on its own.

STRATEGISING A SADC WIDE CONTENT MANAGEMENT

A good CM system will deal with complexity and facilitate practical working relations between different parts of the whole by having the right menus, linkages and functionalities and by having user-friendly walk through tutorials that help the user access different components of the whole. Healthy eco-systems are learning systems that adjust and adapt to new stressors or benefits from the social and natural environments that enter into and change that system. In our strategy of how we want to build the SADC wide content management system, it is helpful to liken a CM system to that of an ecosystem. The CM regulates the user who enters the system to add content and retrieve it and the system, as it thrives with new data, adjusts to the needs of the practioners who in turn learn about the robustness, complexity and adaptive capacity of the system that they engage with. People learn from the CM system and the system, through hits, comments and so forth, learns from people. An online content management system adjusts the prominence of items within its content according to the 'hits' it receives on specific items. It learns what its users want, what the current social and environmental issues are at multiple scales, not only from the interaction reflected through comments or contact emails to the server but by simple hitting on certain items. The system should be resilient to change as it takes in new learning and new learning brings change into the system. 'Hitting' and 'liking' have become powerful means of increasing the responsiveness of certain items to search.

SECURITY AND CONTENT

We operate today within a society where there are more and more risks in terms of the way that users can manipulate the system, for instance, by creating search prominence through engineering hits. Specific user driven content reduces our risk and vulnerability to uncertainty as much as possible. Data must be sufficiently comprehensive for the individual bias to be a stimulus to investigative rigour and the CM strength lies in its ability to attract users who will interrogate, correct and update content. Consistent with the idea of an ecosystemic ethic, complexity is an integral part of management interventions and even more so concerning interventions around ecosystem management. The process of communicating and sharing our knowledge about water resources management is central to the idea of complexity because it allows for multi-level, varied, user-driven, interdisciplinary, relevant and dynamic data. The fluidity of linkages allows for different components of the system to interconnect and this agility percolates new knowledge as the 'old' changes meaning and becomes new. The power of the CM system will be its ability to process new information in novel ways as soon as new data hits the ground. Data must be 1) relevant, 2) accurate, 3) reliable, 4) interactive, 5) valid and 6) simple. Relevance and interaction comes with the terrain (user driven), but the accuracy, reliability, simplicity and validity of the data is something that will be corrected by users. Data that is too complex is likely to be hit on by highly specialized sector users. A typical database is able to present a face to the user which is 'broad' and provides a 'first glance' option. Depending on the particular needs of a user, the database then allows deeper penetration through clicking on a given function. The most obvious example of 'broad' and 'narrow' aspects is around the map zoom and layer function of the CMS Aquaknow.

EVALUATING E-SKILL LEVELS

When evaluating e-skills, it is important to look at how online users are able to use the medium while others are not – in other words to appreciate the differentiated online skills and user needs. More research is needed to access why some users are able to add content, use and manage it while others are not. A survey on e-skills and on the existing use of CM systems was conducted to gather some primary data to assess the e-skill 'readiness' and requirements for the SADC region. Only 36% of expert respondents confirmed that they have a specific group of stakeholders that use a Knowledge (Content) Management

System. Most of the respondents said that they do use some electronic or other e-platform for content management. The range of strategies that were used to manage content included workshops, e-newsletters, e-publications, websites, e-learning platforms, hands on face-to-face training and policy briefs. The primary data gathered from sector experts showed that there is a need for a SADC wide content management system. The study concludes that Aquaknow has the potential to play a significant role in the SADC region by providing the technology for people to interact and to take ownership of a CMS for the sector in the SADC region and beyond. Such a database has the potential to nurture diverse views, debate and to stimulate scientific discussion on contested and important issues in the region. In this way existing capacity is nurtured and new capacity built for the sector to promote integrated water resources management. Aquaknow needs to be sharpened and used regularly so that the site becomes embodied, mirroring the talent, challenges and opportunities open to SADC water sector stakeholders.

CONCLUSION

A given CMS is a hollow vessel unless there is uptake from partners. The technology is only as good as the people who use it – and vice versa because any given CM system pivots around technology and users (people). How can the sector be encouraged to use the database? What functions would make the CM most appealing? How does Aquaknow link with other CMs and finally, what is its competitive advantage? With relevant, accurate, reliable, valid and simple knowledge lodged within the system contributors will see the advantage of sharing and interrogating content. There are a number of powerful content management tools in the sector but many of these are specific either to a country or to a topic. Linkages will be made to relevant repositories of content that can add value to our system. Global CM systems are often managed and owned by parent organizations. The uniqueness of Aquaknow is that it will be owned by the NEPAD Centres of Excellence and will not be country or topic specific. It has the potential to be the central tool around which these Centres pivot. Such a system, because of its interactive nature is likely to have bias. Bias can be an advantage insofar as it fosters investigative thinking and in the process builds capacity of sector users who learn what works and what does not work. The report makes a number of recommendations for making the CMS the most appealing it can be for the CoE's.

Research Methodology

- Existing documents on content management and knowledge management were used to provide baseline data. Ideas were borrowed from theories of ecosystem resilience, epistemology of knowledge, knowledge and security, capacity building, security and risk, e-skills readiness, social learning for sustainability and complex systems thinking
- Some key concepts were defined, notably: knowledge, epistemology, tacit knowledge, explicit knowledge, implicit knowledge, knowledge management system, content management system and functionality
- Content management system dynamics were defined graphically. The relationship between innovation and ideas and practical action and goods was presented
- Four basic rules were isolated, notably: clarity of objectives and quality of design, long term engagement, ownership and participatory diagnostics
- Six fundamental principles for a CM system were identified, notably: relevance, accuracy, reliability, interactivity, validity and simplicity
- A model of a content management system representing the dynamic idea of time and movement was developed
- The idea of broad 'first glance' versus narrow, deeper and detailed zoom options was considered using the map function
- An expert survey was conducted and the findings were presented of expert opinion on e-skills in the Region, use of CM systems, type of CM platforms that are commonly used, whether or not the targeted experts have a CMS and if so whether they use it and whether there is a need for a SADC-wide CM
- Four examples of CMS were identified, notably: a WRC project undertaken by AWIRU and the CSIR that lists 59 records or agreements on transboundary governance, the WARFSA WDM project that defines Management Information Systems and categorises data used for WDM into three broad categories, notably: commercial data, network data and mission specific data. The third content management was the International benchmarking network for water and sanitation (IBNET), the largest public database with 30 000 practitioners and 2400 recorded water utilities throughout the world. The fourth content management system that was selected was the CGIAR, the Consultative Group on International Agricultural Research. CGIAR has a database that is driven by management. It offers a 'gateway to global agricultural knowledge' claiming that 'just one search engine, taps into leading agricultural information databases'
- A survey instrument was constructed to assess the functionalities of the CMS, Aquaknow (see Appendix One). The instrument was emailed to selected SADC experts
- A workshop with 15 post-graduate students was held at the University of the Western Cape to assess Aquaknow functionalities using the same questionnaire
- An evaluation of Aquaknow was completed using responses from the questionnaires
- Recommendations were made drawing on the questionnaire responses, desktop literature and the analysis by the research team of Aquaknow, guided by the expert input.

Table 1: Thirteen step research methodology for KM2.1

KM 2.1 Research Methodology	
Step one: theoretical framework	Existing documents on content management and knowledge management were used to provide baseline data. Ideas were borrowed from theories of ecosystem resilience, epistemology of knowledge, knowledge and security, capacity building, security and risk, e-skills readiness, social learning for sustainability and complex systems thinking
Step two: defining key concepts	The following key concepts were defined: knowledge, epistemology, tacit knowledge, explicit knowledge, implicit knowledge, knowledge management system, content management system and functionality
Step three: concept frame	Content management system dynamics described in a diagram depicting flow between innovation and ideas and practical action and goods through content management
Step four: framing four rules	Four basic rules were isolated, notably: clarity of objectives and quality of design, long term engagement, ownership and participatory diagnostics
Step five: framing six fundamental principles	Six fundamental principles for a CM system were identified, notably: relevance, accuracy, reliability, interactivity, validity and simplicity
Step six: modeling CMS	A model of a content management system representing the dynamic idea of time and movement was developed
Step seven: zooming function examined	The idea of broad 'first glance' versus narrow, deeper and detailed zoom options was considered using the map function
Step eight: investigating e-skills in SADC	An expert survey was conducted and the findings were presented of expert opinion on e-skills in the Region, use of CM systems, type of CM platforms that are commonly used, whether or not the targeted experts have a CMS and if so whether they use it and whether there is a need for a SADC-wide CM
Step nine: selecting four examples of types of databases available in the sector	Four examples of CMS were identified, notably: a WRC project undertaken by AWIRU and the CSIR that lists 59 records or agreements on transboundary governance, the WARFSA WDM project that defines Management Information Systems and categorises data used for WDM into three broad categories, notably: commercial data, network data and mission specific data. The third content management was the International benchmarking network for water and sanitation (IBNET), the largest public database with 30 000 practioners and 2400 recorded water utilities throughout the world. The fourth content management system that was selected was the CGIAR, the Consultative Group on International Agricultural Research. CGIAR has a database that is driven by management. It offers a 'gateway to global agricultural knowledge' claiming that 'just one search engine, taps into leading agricultural information databases'

Step ten: constructing assessment instrument	A survey instrument was constructed to assess the functionalities of the CMS, Aquaknow (see Appendix One). The instrument was emailed to selected SADC experts
Step eleven: working testing Aquaknow	A workshop with 15 post-graduate students was held at the University of the Western Cape to assess Aquaknow functionalities using the assessment instrument
Step twelve: evaluating primary data	An evaluation of Aquaknow was completed using responses from the questionnaires
Step thirteen: recommendations	Recommendations were made drawing on the questionnaire responses, desktop literature and analysis by the team on Aquaknow

Structure of the report

The report is divided into four sections. The first section presents the objectives and then the background to this study. It includes a discussion on ideology, bias and security threats that face a content management systems. As e-skills are so much part of access, use and management of a content management system, the next section looks at e-skills. This section presents some elementary data collected in a small survey of experts in the SADC region. Section three describes some existing databases, selected for convenience, and then provides a substantial analysis of AquaKnow. This is a content management system that is proposed as a pivotal tool for building the Southern African Water Sectors of Excellence. Section four ends the reports with a conclusion and recommendations for the way in which a content management system can promote the SWAp for the water sector.

Section 1: Knowledge Management

1.1 Objectives

The objectives of the study are to list and describe current functionalities of Aquaknow. It will also list the needs of the CoE concerning knowledge, information and data management functionalities. The needs will take into account the water resources management and GIS aspects to be available on-line. The study will identify gaps that exist in Aquaknow.

1.2 Background

The UN Conference on Water (1977) was a first of its kind. The message to the world that resounded from Mar del Plata was that water is a finite resource. We cannot do without this resource because water is life. The seriousness of the alert from Mar del Plata in 1997 was heeded and as an attempt to direct human and financial resources at tackling the problem of global water resources scarcity, it was followed through with the announcement that there would be a Decade, 1981–1990, devoted to International Drinking Water Supply and Sanitation. Embedded in the focus areas of this decade was the acknowledgement that there needed to be strong institutions to drive policy, regulation, use, protection, management and control of the resources. Within this context what is required is not simply the dissemination of information but the development of skills to generate, manage, disseminate and use information so that it improves water resources management. A global Content Management System (CMS) is a fundamental building block for this purpose. A CMS needs to be more than just a means of collecting information and establishing technically sound systems because it must address head-on the world management of the resource, presenting data on demographics, population movements, resource use and changes and so forth, offering possibilities for the protection of this increasingly limited resource.

A number of key concepts used in this document are defined in the table below.

Table 2: Defining CMS key concepts

Concept	Clarification
Knowledge	Acquaintance with facts, truths, principles, general erudition
Epistemology	The study of knowledge
Tacit knowledge	Tacit knowledge was first introduced into philosophy by Michael Polanyi in 1958. Tacit knowledge is defined as work related practical knowledge. It is that which is neither expressed nor declared openly but rather implied or

	simply understood and is often associated with intuition. It is not easy to transfer this type of knowledge to another person but it is shared through 'lived experience.' Tacit knowledge involves personal belief, perspective, instinct and values. The most effective way to transfer tacit knowledge is face to face, also through coaching and dialogue (Frappaola, C 2006). Cross reference com_strategy, JP1.2
Explicit knowledge	Explicit knowledge can be adequately transferred with the help of electronic tools. Knowledge that has been or can be articulated, codified, and stored in certain media. It can be readily transmitted to others. The information contained in encyclopedias (including Wikipedia) are good examples of explicit knowledge. It is rule based
Implicit knowledge	Tacit knowledge is not coded knowledge but if it is to be shared then it needs to be captured. This is the role of stories, anecdotal evidence, videos and other tools that help bring personal tacit knowledge out in the open so that the values and perceptions of people that have been 'hidden' can be shared and codified in these less traditional ways
Knowledge management system	Knowledge Management is the discipline of enabling individuals, teams and entire organisations to collectively and systematically create, share and apply knowledge, to better achieve their objective: (Young, R, CEO/CKO Knowledge Associates International")
Content Management System	The core features of Content Management Systems vary widely from system to system; many simpler systems showcase only a handful of features, while others, notably enterprise systems, are much more complex and powerful. These can: · Allow for a large number of people to share and contribute to stored data; · Control access to data based on user role (i.e., define information users or user groups can view, edit, publish, etc.); · Facilitate storage and retrieval of data; · Control data validity and compliance; · Reduce duplicate inputs; · Simplify report writing; · Improve communication among users. Data is defined as almost anything: documents, movies, texts, pictures, phone numbers, articles etc.
Functionality	The quality or state of being functional; especially the set of functions or capabilities associated with computer software or hardware or an electronic device

1.3 Epistemology of Knowledge

In order to better understand the science of knowledge and to be aware of the ethics behind the system that we will all own and use for the SWAp, it is helpful to contextualise the science and philosophy of knowledge so that we are aware of the responsible position we each have as users and owners of the CMS. According to the anthropologist Clifford Geertz (1973), culture consists of socially established structures of meaning. Knowledge is the socially constructed structure of meaning and as Earl Babbie states in his *"Introduction to Social Research"* despite the power of tradition, new knowledge appears every day. *Often, acceptance of new acquisitions depends on the status of the discoverer" (2007: 5).* This is one of the most important reasons why sources of data need to be reliable. Babbie continues:

> **"we are more likely to believe that the common cold can be transmitted through kissing, for example, when you hear it from an epidemiologist that when you hear it from your uncle Pete (unless of course, he's also an epidemiologist" (2007:5)**

Babbie claims 'there is usually more than one way to make sense of things' (2011:33). Paradigms often create difficulty because they are commonly accepted as one perspective based fact and taken for granted and the person is sure that this is simply the only way things should be.

We are subjective about the way that we interpret the world as we see it. Thomas Kuhn's renowned *The Structure of Scientific Revolutions* suggested that **a new paradigm – a different way of seeing - came to be when the old paradigm was sufficiently challenged.** This is important when considering CM and the core difference between information (explicit knowledge) and meaningful content (includes implicit and tacit knowledge). Knowledge implies that we are organizing our content in a particular way and that it can be applied practically in a given context. It also means that different users see things in different ways and that our system will reflect reality from many angles. This is not always so simple because the paradigm that we are lodged within – our own way of seeing the world – also determines which facts we manage, and how we manage them. Box One below illustrates this point *(Source: Adjusted from Babbie 2011:60).*

Imagine that you and some friends are in a totally darkened room. Each of you has a flashlight. When you yourself turn on your flashlight, you create a partial picture of what's in the room, whereby some things are revealed but others remains concealed. Now imagine your friends taking turns turning on their flashlights. Every person's flashlight presents a different picture of what's in the room, revealing part but not all of it. None reveals the full picture or the 'truth'

Box 1: ways of seeing revisited

1.4 Background to content management

The water sector is considered a knowledge – intensive sector (Boland *et al* 2009). The United Nations Task-Force on Indicators, Monitoring and Reporting final report (2009) defines the water sector as "all means and activities devoted to creating net added value from the water resources available in a given territory. The examples of 'net added value' include production of food, maintaining or improving the health status of the population through provision of potable water etc. The focus on knowledge management is not a 'nice to have' but a 'must have'. The shift is away from simply focusing on the end user, but also on ethical issue of knowledge production that is linked tightly with the way in which content is codified, stored and managed. The information age has spurred on an interest in content management systems and knowledge management. The information revolution offers Africa a dramatic opportunity to go forward into the 21st Century, but as Gumbo *et al* (2002) remind us, *Africa lags behind other regions of the world in usage of Information Technology (IT) and Information Systems (IS).* Quadir *et al* (1999 in Gumbo *et al* 2002) draw our attention to the Global Water Partnership (GWP) initiative which is developing a World Water Vision for 2025, and state that the impact of information technology on the water sector is not inherent in the technology but largely depends on the way society chooses to use the technology. We differentiate in this report between Knowledge Management (KM) and Content Management (CM) and we prefer to call the system that we propose for the sector a Content Management System (as per the definition in table two above). The linkages between the technology and society are at the core of a responsible Content Management System (CMS).

1.5 The role of the CMS

Conscious and intentional generation of content is for a purpose and as shown in the figure below, the development of knowledge is a *process* of conversion of innovation/ideas into action and goods. The emphasis is on the process as there is an interactive and dynamic relationship between innovation and the practical way that ideas transform into action and goods and services that improve people's lives and preserve environmental integrity for future generations. Figure one reflects the interdependence between the impact on society (B) and technology (A).

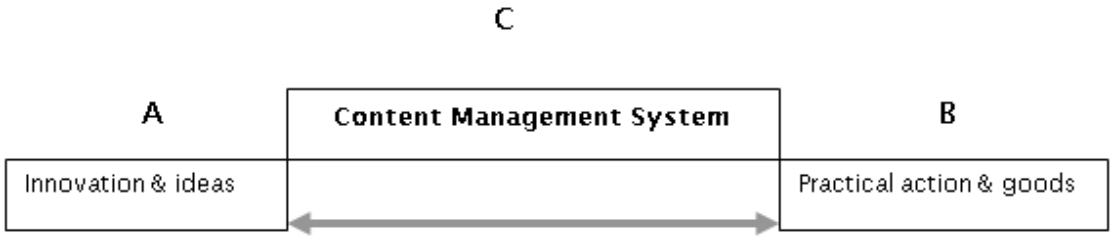


Figure 1: Content Management System Dynamics

There is a healthy tension that can be held within and through a robust CMS where the quest for science and knowledge is continuously measured against the requirement for practical solutions and interventions. Without the ongoing and dynamic interaction between A and B (through C), science remains cut off from society and the urgent needs of the social and natural environments in our 21st century. The system maintains equilibrium and as such is self-regulating. If the ideas are too technical or 'scientific' they will have no appeal to the users and they simply will not be used. As such certain categories of data will not be updated and will lose 'status' simply because they will not have hits. Data that is not helpful for practioners might be stored but it will not be used. The system is the fabricator as well as the mediator of knowledge for practice.

A good content management system should be able to sustain a competitive advantage and should be able to perform intelligently by developing its knowledge assets interactively (Wigg 1999 in Zaim *et al* 2007). This fits well with our approach to content management which is user driven and therefore, by definition, interactive and demand driven.

1.6 Knowledge as Capacity Building

The interactive engagement with a CMS is key to building capacity. Hildebrand and Grindle (1994 in Boland *et al* 2009) propose that capacity is the ability to perform appropriate tasks effectively, efficiently and sustainably. Capacity building cannot be achieved passively although there is 'implicit' knowledge that passes between different people and it could contribute to knowledge acquisition indirectly. We see capacity building as being an active process of engagement in learning. This implies an impulse to acquire new information, to process it and to be part of an engaged community of practice. An essential property of capacity building is that it must be part of an active process (2009:7). For the purpose of the CMS proposed for the SWAp, an essential component is the dynamic nature of the system with an emphasis on the interrelationship of systems (as per figure 1 above).

An essential property of the CMS is the dynamic nature of the system with an emphasis on the interrelationship of systems. This includes the way that content is stored, protected, managed, controlled

The interrelationship includes the way that content is stored, protected, managed, controlled and used. The performance of individuals can be traced by their remarkable ability to adjust, adapt and learn. This agility and adaptive capacity depends on how the knowledge at their disposal is exchanged, reconsidered, abandoned and renewed. A robust content management system will be able to store data that is useful for the community of practice in the present and overtime: the content ranges from simple verbal protocol; oral stories and everyday experiences that have become part of 'knowing' about the world. These experiences are passed on through narratives, myths and legends that are handed down from generation to generation. This is practical know how of the everyday and it is learnt through these oral tales, songs, poetry and other artistic forms of expression that

capture the relationship of man and the universe over time. At the other end of the spectrum are the highly technical and advanced content that is specialized and requires specialized expertise to decode the message.

As presented in table two, data is defined as almost anything, including documents, movies, texts, pictures, phone numbers, articles and so forth. The power of a system that stores a wide range of data, codified in different forms, is that it can capture tacit knowledge and make it explicit.

A significant literature is developing on knowledge and content management. As we deepen democracy the emphasis on users and demand driven processes are linked to issues of human dignity and rights to information as well as the right of ordinary citizens to make sure that efforts spent on science can improve living conditions. Our discourses put climate change and its impacts on the practical agenda. We learn that livestock is one of the biggest consumers of water in Africa, we learn to co-ordinate rain water management efforts, to alleviate poverty and so forth. We learn how contaminants from waste water or acid mine drainage affect our aquifers and we learn how human activities impact on water availability and how ever scarce and changing resources impact on society. It is the relevance of science that, through technology, makes its impact on society.

1.7 Organizing Information Systems

An information system can be defined as a collective of data and tools that stores information in analog form. The information is coded and in order for users to make sense of it, the information must be organized meaningfully. **The collection of data, the databank or database, is a physical repository of varied views of the real world that represent our knowledge at one point in time (Laurine and Thompson 1992)**. In the database context the terms data, information and knowledge are different because a CMS has enough information organized in a particular way so that the person who is using the data can make sense out of it. Laurini and Thompson (1992) give the following example of a bicycle.

> **"This can be represented by circles for the two wheels, various lines of frame, wheel spokes and so on. The geometric entity of the bicycle is the assembly of the data elements; human knowledge is needed to deduce the reality of a bicycle as a means of transportation and the steps necessary for the physical object to function" (1992: 4)**

As the authors state, there are many ways to organize furniture in a house, and there are many ways systematically to arrange information about the water world. This particular CMS proposes the CMS framework for the SWAp, underpinned by the four rules presented above, encouraging the users to engage actively with the data and to further science for

impact – to have enough content available that the bicycle is more than the sum of its parts. Users should be encouraged to add tacit and not only explicit knowledge.

1.8 Characteristics of a CM for a SWAp

With these points in mind and acknowledging that information can be interpreted in different ways at different times, the following four basic rules, adapted from Gumbo *et al* (2002)[1] and building on experience in the construction of indicators, field experience and data analysis, the following are indispensable:

- ✓ Clarity of objectives and quality of design: what is the CM system going to be used for? The design should consider constraints and existing capacity of users to extract information in a meaningful way so that it can be contextualized and relevant
- ✓ Long-term engagement: users will be encouraged to use the system with regular up-dates so that it serves as a long-term repository. In this way content accumulates, becomes richer and is able to take on complexity and change. This allows content to be adjusted and adapted to the needs of the users who bring in new data. In so doing the changing physical, natural and social environment and changing ideas that influence our way of thinking and doing in the water world, will be reflected
- ✓ Ownership: the system needs to 'belong' to the SADC community of practice. It will be meaningless if the only users are the people who created it. It needs to be connected and to connect sector partners in the Region and to be a recognized tool because it serves the needs of sector partners in the Region and beyond
- ✓ Participatory diagnostics: the system requires input from its users and the input will have to be assimilated, interpreted and used to construct new knowledge in a cyclical and organic way as content is added, removed, developed and negotiated. The idea of ownership implies also that SADC sector partners interact with each other, deposit data, extract data and process ideas that are shared, discussed, debated, dissented and negotiated overtime, shaping new discourses and advancing science

With the urgency of problems that face the globe in the 21st century, unless there is uptake of science, the ideas and innovation might as well not happened.

Figure 2 reflects the key elements in a CMS. The first level takes up the message conveyed in figure 1 above, namely that the system is able to take on an intelligent tension between ideas and innovation (science acquisition) that creates knowledge and the way that these ideas can impact in a practical way for society. On the left hand side of the face of the clock, we have 'science acquisition' and on the right hand side 'society and practical impact. The quest for knowledge, for the sake of learning more about the world we live in, is in itself a worthwhile pursuit. However, with the urgency of problems that face our planet in the 21st Century, we must pursue science for a purpose.

[1] And subsequent seminars within the context of a Water Demand Management Module offered for WaterNet Master's Students

There is an urgency to make research and our scientific findings relevant and part of a process of problem solving and engagement with our natural and social environment. If we ignore this purpose, the ideas and innovation might just as well not have happened because poverty, deprivation and degradation of our social and natural world will continue.

At the second level, in Figure 2, we reflect on the gap that exists between e-skill literacy, represented on the left hand side and tacit knowledge on the right hand side. We assign the term 'literacy' to tacit knowledge because we believe it acquires a skill and one needs to learn how to read and interpret tacit knowledge. Tacit knowledge (stories, messaging and intergenerational and cultural transfers of knowledge) is as powerful in its oral and practical codification (stories, video's etc.) as is conventional technology and analogue translation of ideas that is represented on the left hand of the clock.[2] Goldin (2005, 2010) and Thompson (2002) draw attention to the 'science of the people' and how the subjective and personal, the 'feminine' often gets squeezed out of public spaces despite the fact that it reverberates throughout the institutional and public sphere.

At the lower level, the model reflects the tension and interface between broad and general knowledge acquisition and value on the one hand, and more practical context specific knowledge on the other.

The circle has arrows that represent the hands of the clock. The metaphor of the clock is significant as it captures the dynamic and always changing face of a given content management system. The hands of the clock move: today becomes the future and contains the past and yet the system moves constantly and there is a determined forward looking advance through interaction of users (sector wide partners) who keep the ideas flowing, ticking into the future and carrying innovation through science into society.

[2] To expand on definitions provided in table two it is worth noting that active knowledge is usually technical in nature, like engineering, accounting, design as it involves a lot of doing. Passive knowledge is knowledge that has benefits even

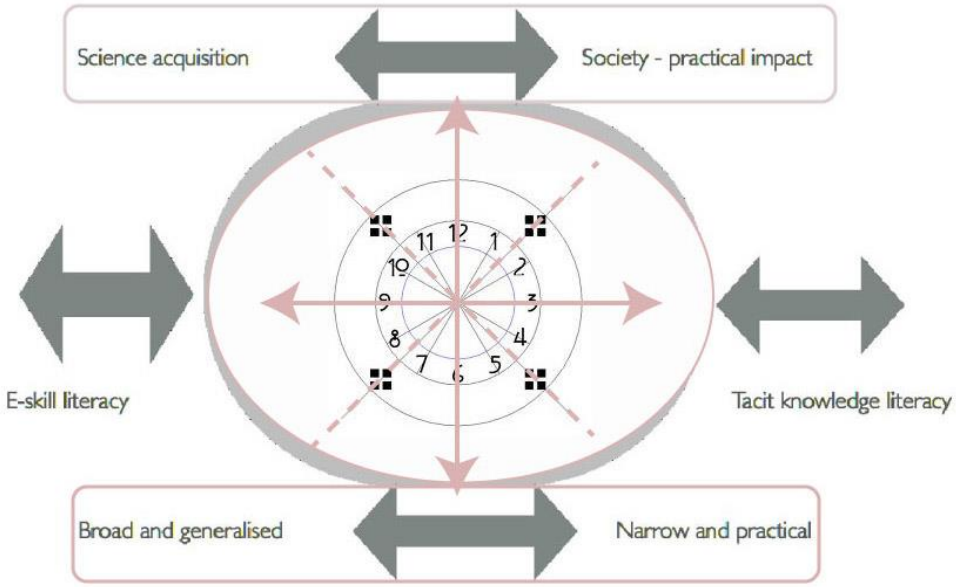


Figure 2: Model of a Content Management System representing the idea of 'time' and movement and ongoing transmission of ideas represented as the face of a clock

1.9 Ideology and Content Bias

Ideas are not self-sufficient and as the literary scholar and philosopher Stuart Hall (1977) claims, they come from somewhere and go to somewhere and they have causes and consequences. As presented in the section 1.3 above on the epistemology of knowledge, Hall argues also that the roots of current 'ideas' and 'ideologies' lie beyond the narrow context in which they may manifest. Hegel states "particular knowledges – one-sided knowledge, knowledge at any particular moment – were always partial" (in Hall 1977:11). A content management system is only as good as the content that is made available on it. Traditionally what one brings to the framing of research questions (and hence the data collected), results from a given background and identity. It carries a label of some perceived bias and there is an assumption that the bias needs to be eliminated rather than that the bias should be treated as a valuable component. More recently, Denzin and Lincoln (2000) and Jansen and Peshkin (1992 in Bickman and Rog 2009) have shown that bias in individual items of knowledge can actually be an advantage, adding thought-provoking value to the repository within which bias resides. The existence of various biases on any one topic can be an advantage insofar as it fosters investigative thinking - the root of problem-solving.

Bias in individual items of knowledge can actually be an advantage, adding thought provoking value to the repository within which bias resides.

Bickman and Rog (2009) contrast knowledge use against knowledge production, indicating the differences in purpose of each. Applied research strives to improve the understanding

of a problem – and contributes to the solution of that problem. Take the example of Aquaknow where, as a CMS relevant to the sector, Aquaknow is able to improve the understanding of the water world as users deposit thought-provoking pieces and scientific data on the system. It achieves this by producing a very specific, goal-directed repository – the intent being to contribute to solutions of specific problems related to the water sector.

1.10 Content Management and Social Learning for Sustainability

Sustainable development requires processes of change in society. It is helpful to refer to the work of Senge (1990) and Roth and Senge (1996) who apply the idea of social learning within organizations. These authors consider learning processes within a framework of systems thinking. In other words, performance of individuals impacts on the 'system' as a whole. A system is made up of interactive and shared visions of its actors. This way of thinking requires a linking of different components, making connections and relating different functions to each other. Senge (1990) and Roth and Senge (1996) make use of the idea of synergy and diversity. From the moment human beings enter an ecosystem it is incumbent upon them to think in terms of sustainability and impact that reverberates through the system. It is useful to embed the idea of a CMS for the CoE's within this concept of social learning as it gives the actors a sense of their responsibility as a cog in the machine of a greater system. In other words, the system does not exist 'out there' apart from the actors but it is intimately locked into a whole that reverberates through the interconnections between people and the technology that they are relating to. A powerful CMS is fundamental to social learning because, as actors link into the system, together they are providing comprehensive information on the water conditions, climate, flora and fauna of the indigenous system, and ongoing predictive data on the effects of human intervention. It is within the *ecosystemic ethic* that we see the true value of CM, its potential for simplifying complexity and facilitating interconnections. No one aspect of a system stands on its own because the system is the technology and the practioners who interact, use, manage, reflect on the data that is stored and disseminated. The system is a meeting point of actors and the technological tool – with its varying functionalities. A good CM system will deal with complexity and facilitate practical working relations between different parts of the whole. It does this by providing menus, linkages and functionalities and by having user friendly walk-through tutorials that help the user access different components of the whole. Healthy eco-systems are learning systems that adjust and adapt to new stressors or benefits from? that enter into that system. People learn from the CM system and the system, through hits, comments and so forth, learns from people.

An online content management system thus adjusts the prominence of items within its content according to the 'hits' it receives on specific items. It learns what its users want,

what the current social and environmental issues are at multiple scales, not only from the interaction in comments or contact emails to the server but by simple hitting on certain items. Van der Leij (2007 in Wals *et al* 2009) note that the number of Google hits for the term 'social learning' increased from around 400 000 to 900 000 in the period between August 2005 and November 2006. As a community of practice develops around the NEPAD Centres of Excellence, new learning will take place as users retrieve, reject, recreate and manage new 'facts' around water. The system should be resilient to change as it takes in new learning and new learning brings change into the system.

1.11 Security, ethics and risk

In our post-modern age a CMS is completely online. Management of such a CMS requires a high level of ethical wisdom. If submission of material were entirely open, it would be possible for instance, for a corporate entity, activist NGO's or provocative practioners working in the sector, to flood such a website with articles favouring a proposed project and 'disproving' environmental concerns raised. As the site gains recognition as being the 'face' for 'facts' and a space where science meets society, it is possible that data posted on a site presumed by the world-wide public to be 'environmentally aware' and promoting the science of water, will lend power and credence to its proposed project. This could legitimize bias and garner public support for a cause that is destructive for our environment in general and for water resources in particular. We could learn, for example, that a particular coal mine is creating jobs and is not a threat to the ground water in a particular aquifer. We could be bombarded with a host of articles that ignore the threat of acid mine drainage and other possible threats to environmental integrity. A website, such as AquaKnow, could also become glutted with to-and-fro slanging matches between opposing parties on a particular water-related issue.

However, we do not believe that such a system would in fact fall prey to undue threats of this nature. We believe in the idea of 'eyeballs' where actors are vigilant to content and counteract bias by posting more grounded points of view on issues, allowing a user who does not have the expertise – in this case in ground water pollutants – to make up his or her mind. It would need a space in which such word-wars could take place, but this component of the CMS would be identified clearly as the domain of opinion rather than fact, one that has boundaries that protect the actual database from contamination.

'Hitting' and 'liking' have become powerful means of increasing the responsiveness of certain items. Users can also manipulate the system by creating search prominence through engineering hits. This has become a powerful influence on what society perceives as being the current issues of importance but is also one of the security risks.

We operate today within a society that is constantly in motion and where there is a risk of information overload and levels of complexity that can be overwhelming. More than ever

we face challenges for which no ready-made solutions are available. With the additional uncertainty and risk that comes with climate variability – and environmental changes - this is especially true of the water sector. In order to respond appropriately to these challenges we need to think and work together in larger communities of shared information, and co-ordinated action. We can no longer afford to rely simply on one source of knowledge but need a robust global water-related CM system that links us into data that we can critically review and that has the ability to inform the way we see the world as it is today. This reduces our risk and vulnerability to uncertainty as much as possible.

Data must be sufficiently comprehensive for the individual bias to be a stimulus to investigative rigor. If it were too narrow in scope, it could become a means of manipulating the user's perceptions in the short run and in the long run compromises the security of our natural and social environment.

1.12 Complex systems thinking and knowledge production

Complexity is an integral part of management interventions and even more so in interventions in ecosystem management. Central to the idea of complexity in water-related communication, is the timeous generating, managing and sharing of data in which the linkage systems between the data are always different. The fluidity of the linkages allows for different components of the system to interconnect and this agility percolates new knowledge as the 'old' changes meaning and becomes a novelty. The power of the CM system will be its ability to process new information in novel ways as soon as new data hits the ground. The generation of knowledge about complex systems is the sum of technical information and societal relationships to this technology (Haas 1980 in Turton 2002).

Data does not constitute knowledge (differentiated from information). The data must be processed and evaluated before it becomes knowledge and there needs to be some consensus on the validity of initial data as well as on the methodologies used to evaluate this data if the output is going to be 'knowledge' (Turton 2002). In other words there is some form of assimilation of the information and agreement on the methodology so that the assimilated data can generate new knowledge and new ways of seeing a given situation. According to Turton (2002), the difference between information and knowledge is the process of legitimization. Knowledge is institutionalized and it becomes legitimate because it results in institutional learning.

1.13 What type of data do we want to see in a CM system

The following table presents six fundamental elements that have been adjusted from Gumbo *et al* (2002) and our own field experience in gathering indicators and analyzing

data. The CMS must reflect information that is 1) relevant, 2) accurate, 3) reliable, 4) interactive, 5) valid and 6) simple.

Table 3: Fundamental principles for a CM system

1. Relevant	We find it relates to the sector we work in
2. Accurate	We trust the source and information that we find
3. Reliable	We know that if we go into a KM system we can find what we are looking for
4. Interactive	We know that the system can tolerate and learn from feedback loops between its users
5. Valid	It is reflective of reality
6. Simple	Lay persons can understand it

As the system we propose is user driven, points 1 and 4 are the easiest to achieve. The content will be relevant because the user will only post data on the site because they deem it to be relevant. It will be interactive because the act of posting means that there is already an interaction and there will be feedback loops between users who use, change, comment on, take-up or ignore the data. The properties of being reliable, valid, accurate and simple are properties that will be regulated by the user. The more the sector takes on ownership of the system, the more likely we are to have experts who interrogate and reject data that is not reliable and accurate and that it not reflective of reality out there. Data that is too complex is likely to be hit on by highly specialized partners.

1.14 Practical versus statistical significance

Bickman and Rog (2009) differentiate between broad and narrow questions. The six elements presented in the table above are relevant to a database that is constructed to provide content for broad or/and narrow questions. Aquaknow, for instance, as a typical database is able to present a face to the user which is 'broad' and depending on the particular needs of the user, the database then provides entry through clicking into it and going into a deeper level. The most obvious example of 'broad' and 'narrow' aspects can be seen in the zoom and layer function. These approaches are controlled and not random. The user can choose to remain at the 'broad' level or to go 'narrow'. The idea of a 'helicopter' and a 'plough' is helpful. The helicopter flies over the field and takes a broad view of what's beneath whilst the plough hones in at a scale on the ground where every row in the field is visible.

Another useful distinction is made by Bickman and Rog (2009) who distinguish between practical and statistical significance. For these authors, there is a broad-brush significance of generalizations drawn from statistics versus the results of specific practical applications.

If one is speaking to the general public the practical view (helicopter) solicits greater interest. The scientist, on the other hand, might want to have access to the plough with a more detailed statistical picture with higher resolution. Let us take a 'fact' that is presented on a given site such as 'the reduction in water consumption is 10%.' What does this statement mean? What is the practical significance of this number and why should someone want to know that statistic? Is this trivial or important? How was the percentage calculated? Was it based on calculations of total previous consumption or on consumption per capita – in which case total consumption could well have risen with population growth and the 10% reduction is illusory. The system must be able to settle on deeper specific facts but not lose out on the helicopter view either.

Section 2: E-skills

2.1 Introduction

Schmidt and Stork's (2003) research has shown that those who are able to access the internet are more able to participate as active citizens (than those who have no access). It has become increasingly clear that those who do not have access to the internet are disadvantaged in terms of consumer participation and in terms of access to content. Internet penetration and usage is uneven across developed and developing country contexts – and is also varied within countries. Private access is limited to households who have adequate income to purchase their own PC and for the low-income groups PC penetration is expensive and unreliable. Many people who do have access complain about unreliable access – the costs are high or/and there is limited band-width resulting in data download that is slow. The authors go on to question why e-skills are so important and they argue that as more people start using the web for communication and information retrieval; it becomes less useful to merely look at binary classification of who is online when discussing questions of inequality in relations to the internet (Dimaggio and Hargittai 2001 in Schmidt and Stork). But, what is more important is to look at how some who are online are able to use the medium while others are not – in other words differentiated online skills. More research is needed to access why some users are able to add content, use and manage information and others are hesitant, unwilling or unable to do so.

2.2 How do we measure e-skills?

According to Schmidt and Stork, most e-readiness studies fall into one of the following three categories 1) not considering ICT skills at all 2) interpret use as an indicator of the ability to use (imply that they have the skill just because they are using the internet and 3) include widely available education indicators, such as adult literacy. These authors explore other e-skills assessments such as the OECD's Directorate for Science and Technology and Industry (DSTI) who have 15 Key ICT indicators. They report on the Partnership on Measuring ICT for Development that was formed in 2004 where the most active organizations included ITU, OECD, UNCTAD, UNESCO Institute for Statistics, the UN Regional Commissions (UNECLAC, UNESCAP, UNECA), the World Bank and EUROSTAT.

These bodies divided indicators into the following four categories: 1) ICT infrastructure, 2) access to and use of ICT by households and individuals 3) use of ICT by businesses and 4) ICT sector and trace in ICT goods (Schmidt and Stork 2003: 7). The World Bank's Knowledge for Development Programme publishes a set of score cards based on the Knowledge Assessment Methodology (KAM) that allows combinations of 83 variables, and data for 140 countries. The Knowledge Economy Index (KEI), produced by the World Bank,

is based on KAM and uses 12 variables to describe a country's overall preparedness for the Knowledge Economy (ibid).

Schmidt and Stork's (2003) study also present the Networked Readiness Index (NRI) which was developed at Harvard University's Centre for International Development. In short, they conclude that the majority of ICT indices have a common thread and that is an understanding of ICT access as physical access (including whether or not the user can afford access). They are critical of educational attainment as an indicator although most of the studies do include some assessment of level of education. The problem with this assessment is that it makes certain assumptions – for instance a student who has completed secondary education at Oxford University has, almost certainly, been exposed to the internet but a student at North West University in South Africa, might not have been even though they have the same level of education.

For this reason alternative measures of e-readiness or e-skills include self-reported confidence levels as presented in the tables below:

Table 2: Source: Schmidt and Stork (2003) Assessment of e-skills

Please rate on a scale from 1 to 5 how confident you would feel if you had to carry the following tasks with 1 meaning not confident at all and 5 very confident	
Using a search engine to find information	
Using e-mail to communicate	
Typing a letter or CV on the computer	
Participating in an online discussion forum	
Making a call over the internet	

And typically also include doing a survey on end-users as presented in the table below.

Table 3: Source Schmidt and Stork (2003) Assessment of end-users

Please rate on a scale from 1 to 5 how confident you would feel if you had to carry the following tasks with 1 meaning not confident at all and 5 very confident	
I know about the internet	
Using the internet	
Using a search engine to find information on the internet	
Typing a letter or CV on the computer	
Participating in online discussion forums on a topic of your interest	
Making a call over the internet	

Section 3: Findings from Expert Survey

An on-line survey was conducted to assess e-readiness, use of e-technology. The survey was answered by 36 respondents from 8 countries, the majority of them (80,55%) are from South Africa (47.22%) and Zambia (33.33%), and the remaining 19.45% from Zimbabwe (5.56%), and Mozambique, Bostwana, Namibia, Mauritius, and Lesotho (2.78% each country) (**Figure 1**).

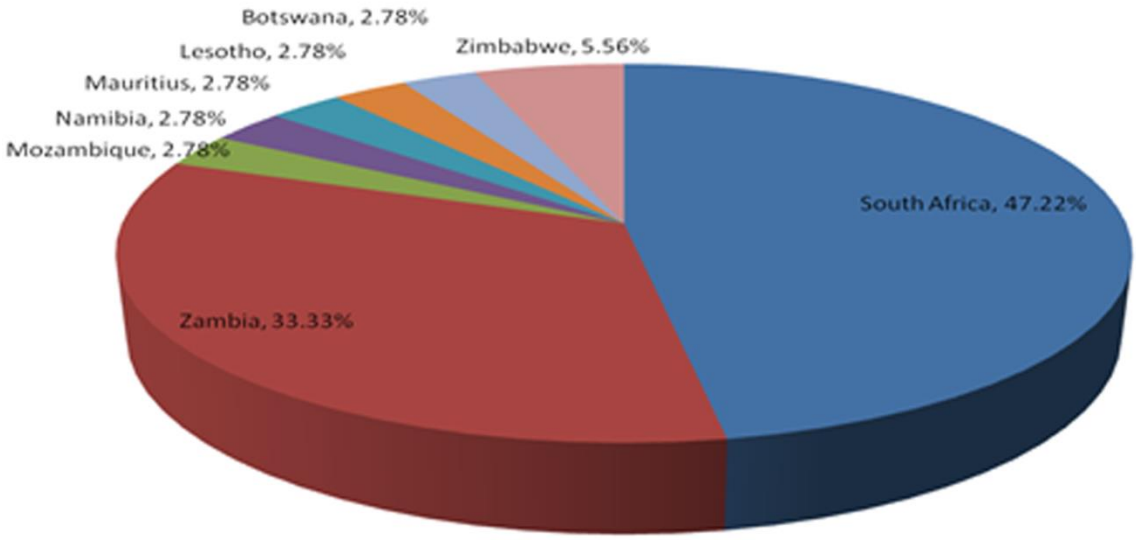


Figure 1: Respondents of the survey

The tables 6 to 10 following provide a quantitative analysis of the respondents' answers and the annex to this analysis provides the descriptive details of the answers that were captured.

According to **Table 6** below, 52,78% of the respondents were aware of capacity development strategies or skills audits carried out in their countries or in the SADC region. The table provides the distribution of the respondents by country. The two respondents from Mauritius and Lesotho are not aware. Some of the development strategies identified are the WaterNet programme in the SADC, water sector capacity and needs assessment, water sector capacity building, skills and capacity building audits and programmes as well as training policies.

Table 6: Other skill audits in SADC

Country	Yes	Percentage
South Africa	11	30.56%
Zambia	3	8.33%
Mozambique	1	2.78%
Namibia	1	2.78%
Mauritius	0	0.00%
Lesotho	0	0.00%
Botswana	1	2.78%
Zimbabwe	2	5.56%
Total	19	52.78%

Table 7 shows that only 47.22% of the respondents said that they used a formal knowledge management system. The three respondents from Namibia, Mauritius and Lesotho said that they do not have a formalized knowledge management system. Databases, learning events, research, training and teaching actions are some of the knowledge management systems that were recorded.

Table 7: Have formal KMS

Country	Yes	Percentage
South Africa	9	25.00%
Zambia	4	11.11%
Mozambique	1	2.78%
Namibia	0	0.00%
Mauritius	0	0.00%
Lesotho	0	0.00%
Botswana	1	2.78%
Zimbabwe	2	5.56%
Total	17	47.22%

Table 8 shows that only 36.11% of the respondents confirmed that they have a specific group of stakeholders that use a Content Management System. While the two respondents from Namibia and Lesotho confirmed not to have it, the two from Mozambique and Botswana did not provide any answer. Among the identified stakeholders who use Knowledge Management Systems are: Nepad Water Centers of Excellence, Ministries, the UNESCO network, the water and sanitation organizations and the Africa Groundwater Network.

Table 8: KM stakeholders

Country	Yes	Percentage
South Africa	7	19.44%
Zambia	4	11.11%
Mozambique	0	0.00%
Namibia	0	0.00%
Mauritius	1	2.78%
Lesotho	0	0.00%
Botswana	0	0.00%
Zimbabwe	1	2.78%
Total	13	36.11%

Most of the respondents (72.22%) said that they use a specific electronic or other platform for knowledge management, with the exception of the Namibian respondent who said that in their country they are not familiar with knowledge management tools and don't have one at all. The range of strategies that were used to manage knowledge included workshops, publications, websites, e-learning platforms, training and policy briefs.

Table 9: KM platforms

Country	Yes	Percentage
South Africa	12	33.33%
Zambia	8	22.22%
Mozambique	1	2.78%
Namibia	0	0.00%
Mauritius	1	2.78%
Lesotho	1	2.78%
Botswana	1	2.78%
Zimbabwe	2	5.56%
Total	26	72.22%

As reflected in **Table 10** below, most of the respondents (75%) said that there is a need for a SADC wide knowledge management system. The respondent from Zimbabwe did not provide any answer to this question. Mozambique stressed the need for co-ordinated efforts in KM as this was considered to be good practice and also avoided reinventing the wheel.

Table 10: Need for a SADC wide KM

Country	Yes	Percentage
South Africa	12	33.33%
Zambia	11	30.56%
Mozambique	0	0.00%
Namibia	1	2.78%
Mauritius	1	2.78%
Lesotho	1	2.78%
Botswana	1	2.78%
Zimbabwe	0	0.00%
Total	27	75.00%

The section below presents four examples of content management systems. The fifth content management system is Aquaknow and as the system is under scrutiny for the purpose of this report because it is considered as an appropriate CMS for the SANWATCE CoE's, the section provides an in-depth analysis only of Aquaknow. The other four systems are merely presented to contexualise the environment within which Aquaknow itself is located.

Section 4: Examples of content management systems[3]

According to the Atlas of International Freshwater Agreements, there are at least 263 rivers in the world that either cross or demarcate international political boundaries. According to the same source, the physical, economic and social disparities between riparian nations that share river basins make their management complex. A Water Research Commission (WRC) funded project on South Africa's cross-border freshwater agreements was undertaken by the African Water Issues Research Unit (AWIRU) and the CSIR. There had been no central repository for shared rivers and the long history of South Africa's four main international resources with its neighbours, namely the Inkomati, Orange, Limpopo and Maputo Rivers have been signed. Some agreements were housed at the Department of Water Affairs and Forestry (now DWAE) and others at the Department of Foreign Affairs but many agreements pertaining to international fresh waters were not on record. As these agreements are the primary tools to promote co-operation between basin states over shared water resources, any oversight documents need to be readily available. The central database contains 59 records or agreements that South Africa has entered into up to the 2004. It is not an exhaustive list but it does lists those agreements that play a

[3] WRC Report No 1515/1/06. See http://www.fwr.org/wrcsa/1515106.htm for exec summary

direct role in the definition and management of international water resources, in particular transboundary rivers, that South Africa shares with its neighbours.

4.1 WARFSA Water Demand Management Project

Gumbo *et al* (2002) define a Management Information System (MIS) for effective implementation and monitoring of Water Demand Management (WDM) in urban centres of Southern Africa. As these authors stress, WDM features prominently in the Southern Africa Vision for Water, Life and the Environment in the 21st Century. WDM seeks to increase the efficiency of water use and in order to do so it examines the complex systems related to water use, allocation, pricing, communication, technology, management - considering WDM to be achievable only if managed in a holistic way. Gumbo *et al* (2002) consider an MIS to be pivotal to the achievement of WDM because water utilities cannot function efficiently without information systems that address and integrate the multiple aspects required for the implementation of a successful WDM strategy. WDM in urban centres in southern Africa has been unable to establish meaningful programme objectives due to the lack of data and the lack of a comprehensive information system to aid decision-making and planning. A water authority is dependent on data for its scientific, engineering and operational function. Data for WDM was categorized into three broad categories: commercial data, network data and mission specific data defined in the table below:

Table 4: Three categories of data required for WDM: adapted from Gumbo *et al* (2002)

Commercial data	All data describing a consumer connection	Plot and property database: data associated with each plot (commercial, industrial, residential or informal) each has a permanent identifier for each water connection. It also has a meter database which includes data relating to the meter (size, make etc) and a customer database (name, ID etc)
Network data	All data representing the infrastructure that conveys water from source to consumer including bulk conveyance and storage, distribution pipes and reservoirs, pump stations and valves	Accurate representation and modeling of system performance. This in turn provides a more efficient means for demarcating meter and pressure zones so as to prioritise and reduce un-accounted for water
Mission specific data	All peripheral data required to satisfy a certain specific mission or goal. This may include water quality, return flow and effluent characteristics, cadastral and other GIS based datasets	Can improve the database and information derived, it can report on service interruptions, abstractions and so forth

4.2 The International Benchmarking Network for water and sanitation (IBNET)

This is advertised as a global database of the water sector's performance and the largest public database - 30 000 practitioners and 2400 utilities. It reports the water price charged to the domestic users per cubic meter for the first 15 cubic meters consumed through the 20 mm (58 inch) pipe according to a set formula. IBNET claims to provide guidance on indicators and definitions, facilitates the establishment of national or regional benchmarking schemes and undertakes peer group performance comparisons. It forms part of the water and sanitation program at the World Bank. It has a comprehensive map of all the countries that have been benchmarked. For example, on clicking on Albania (general – brad) the user can then enter into the narrow specific locations where benchmarking is available. Typical benchmarking, for the town of Malakaster, for instance, is available through the toolkit. An example of the data for 2006 is presented in the table below:

Table 5: Benchmarking from the town of Malakaster (2006)

Indicator	2010
1.1 Water Coverage (%)	47
2.1 Sewerage Coverage (%)	29
4.1 Total Water Consumption (l/person/day)	72
4.7 Residential Consumption (l/person/day)	66
6.1 Non Revenue Water (%)	74
6.2 Non Revenue Water (m3/km/day)	61.9
8.1 % Sold that is Metered (%)	21
11.1 Operational Cost W&WW (US$/m3 water sold)	1.25
12.3 Staff W/1000 W pop served (W/1000 W pop served)	n/a
18.1 Average Revenue W&WW (US$/m3 water sold)	0.55
23.1 Collection Period (Days)	n/a
23.2 Collection Ratio (%)	162
24.1 Operating Cost Coverage (ratio)	0.44

The IBNET toolkit includes a set of core indicators from which stakeholders can build their own customized measurement and monitoring system. The toolkit can be downloaded from http://www.ib-net.org/. See also ibnet@worldbank.org and www.iwaponline.com for a list of journals with information on the water sector.

4.3 The Consultative Group on International Agricultural Research (CGIAR)

The Consultative Group on International Agricultural Research (CGIAR) is a global partnership that unites organizations engaged in research for sustainable development with the funders of this work. The funders include developing and industrialized country governments, foundations, and international and regional organizations. The work they support is carried out by 15 members of the Consortium of International Agricultural Research Centers. These work in close collaboration with hundreds of partner organizations, including national and regional research institutes, civil society organizations and academia.

The site offers a 'gateway to global agricultural knowledge' and claims that '.. just one search engine, taps into leading agricultural information databases, including the online libraries of the CGIAR Centers and the CGIAR's Core Collection Database". It invites the uses to use the CGVLibrary to discover resources and to go directly to full text of thousands of publications. The site informs its visitors that CGIAR scientists work in over 100 countries and that they address every critical component of the agricultural sector. Thirteen of the 15 CGIAR Centers are located in developing countries and the knowledge gathered is shared and disseminated across the world. (http://www.cgiar.org/vic/index.html).

The CGIAR is a comprehensive site that offers information on current research projects around the globe (http://ongoing-research.cgiar.org/) and key findings and research interests. It also offers links to NGO's and other research organizations around the globe.

Section 5: Analysis of Aquaknow

5.1 Aquaknow

The thrust of the report that follows is an analysis of Aquaknow. Aquaknow's home page is captured in the screen shot following:

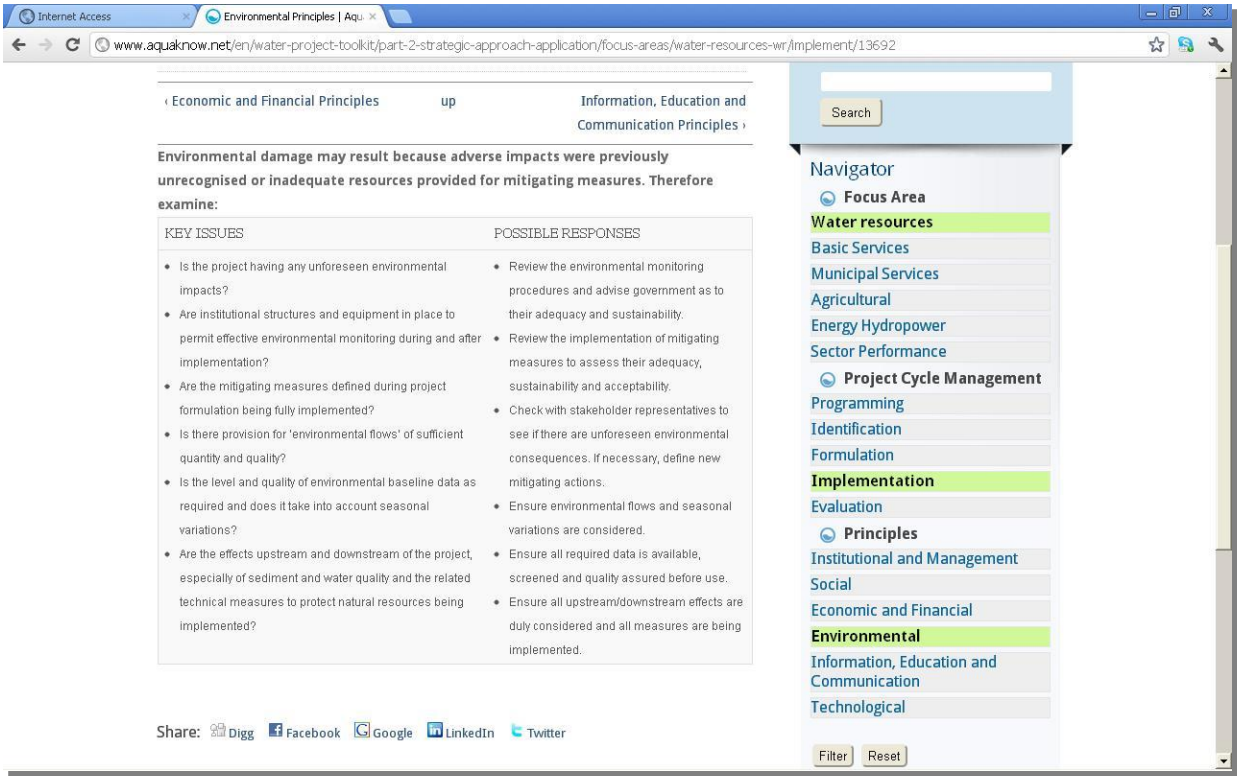
Screenshot 1: Aquaknow homepage

When opening the home page of Aquaknow (http://www.aquaknow.net/en/home) the user sees a friendly, inviting page with places to interact immediately.

A click on the menu allows the user to 'quick view' of the following functionalities: *data, events, library, news* and *community groups*. The user has 'free' and 'unregistered' access to the site and its content. The unregistered user is anonymous. The number of hits on a site can be recorded but the characteristics of the user cannot be analysed. The map functionality cannot be accessed by the user without registering.

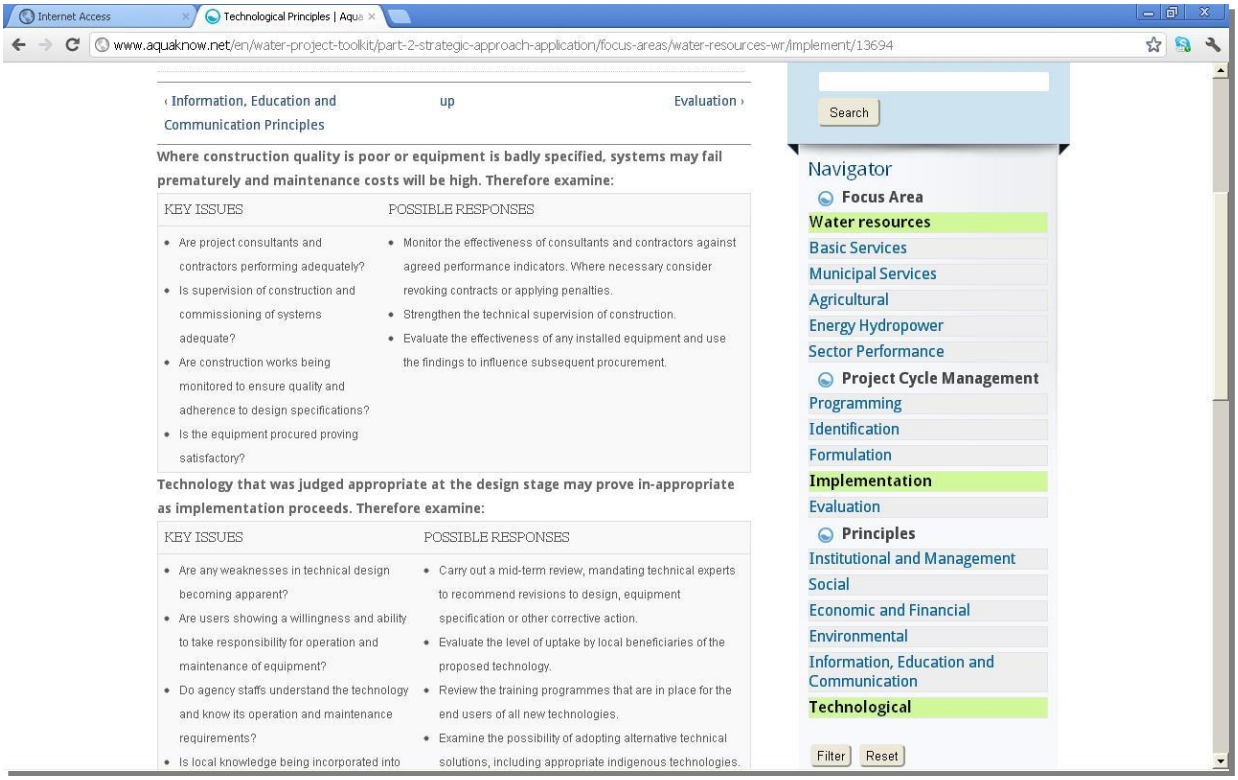
An unregistered user can access the *water project toolkit* section of Aquaknow and receive very useful information on how to define, implement and evaluate water sector development projects through the following sections: rationale and key concepts, strategic approach and policy summary. The unregistered user can also enter into the water project toolkit walk through. This is a 'guide' on how to use the *water project toolkit* in .pdf format. Besides there is a "Water Toolkit Book visualizer" allowing to read online the document. This can be done while logged in as a registered user or not. The Aquaknow gives the following additional functionalities to make the document interactive: *navigator, focus areas, project cycle management* and *principles*. By choosing a focus area, *water resources implementation*, for instance, under the category *project cycle management* and then the focus

area *environment*, under the category *principles*, then activating the function *filter* the following screen appears:



Screenshot 2: Navigator toolkit option one

The user can chose a number of filters and by filtering a different focus area, project phase or *principle* (see screenshot below), in this case *technological,* there is a new dimension of content provided:



Screenshot 3: Navigator toolkit option two

This is a powerful tool and it provides valuable information that can be filtered uniquely for a given user. Navigator toolkit is a highly specialized tool, it would be helpful to have a 'walk through on-line user friendly tutorial' that goes with it. There is a navigator toolkit tutorial but it does need to stand out clearly for the user.

The *in focus* functionality appears to be a fairly arbitrary news function. *In focus* could be more specific and focus on headlines across the globe on water. Publishing in the 15 groups *latest news* is consolidated on the home page under *latest news*. All the latest documents, *latest news*, *upcoming events* and *latest data* are consolidated on the home page. Community members from the different groups will add value to the *in focus* site once they recognize its use and should be encouraged to post documents, latest news, upcoming events and latest data. A larger font saying 'post here' and 'share your news' would encourage users to add content to *in focus*.

5.2 Aquaknow evaluation

A structured questionnaire was designed to evaluate specific functions of Aquaknow (see appendix one questionnaire attached). Thirty six water sector scientists were interviewed

and asked to give feedback, guided by the questionnaire. The following observations are pertinent:[4]

1.1 Please locate the on-line water-sector Knowledge Management System (KMS), at www.aquaknow.net. On a scale of 1 to 5 (1 being least favorable and 5 being most favorable), please rate your first impressions of the site, in terms of

Speed that the site loaded

1	2	3	4	5

Observation: this was an easy task and the intention was to familiarize the user with the five-point response scale and with the general flow of the questionnaire. The PC's were opened up and then all participants accessed the site www.aquaknow.net and were invited to begin navigating. Speed varies from one county to another, from region to region, institution to institution and within an institution the speed varies. Variation in speed was noted during the practical workshop task. Out of the 20 PC's, 17 PC's took more than 5 minutes before the Aquaknow site would open. In the same browsing session, the facilitator asked the participants to open up two other 'test' sites. The first site was a South African based site, www.news24.com and the second site was an American site, www.cnn.com. The purpose was to compare the relative speed between Aquaknow and the two sites. Both 'test' sites opened up significantly faster than Aquaknow.

During the workshop users accessed the 'water project toolkit' which allows the user to 'create' and through a highlight menu the user is invited to interact with the *Water Project Toolkit*, *Training on Water Issues* and access to a *Data Web GIS* and *Repository*. It asks the question of the user '*Looking for Data and/or online analysis tool*? The function tells the user that *this section gathers the online databases on projects and raw data to help you finding the information you need*. Aquaknow emphasis is on the interactive component and it tells the user that the robustness of this tool depends on *collaborative work* and that there is an opportunity to *enhance it by adding directly your own entry and share it with the community*.

The system provides a Web GIS tool to visualise and access maps and graphs of datasets. When clicking on the 'go to the dataset (http://www.aquaknow.net/en/data/gis) the user must wait while the system downloads and allows access. This is a slow process but what matters is that Aquaknow is an open user driven system and it depends, as the discussion above has indicated, on the interface between technology and society.

[4] Not all questions are presented in the report. The full questionnaire can be found in the appendix. Where there were no comments the question has been left out of the report

Activity 2: Register

2.1.1 If you have never registered as a user at Aquaknow.net *please register.*

2.1.2 If you have registered at the Aquaknow.net site previously, *please log in.*

On a scale of 1 to 5 (1 being not easy at all and 5 being very easy), was it easy to locate the registration function of the site?

1	2	3	4	5

The wording of *create an account* could be changed to *register*. Most of the participants agreed that the function 'register' would make a user feel more secure. Registration also helps keep track of members. Registration could be speeded up and automated so that there is not a 12-24 hour delay in receiving a username and password. Here again there some users who received their password quickly (within a couple of hours) but others only received their password several days later. The function to register is not the best. Once registered, the user can join and contribute to community groups, receive updates from all the community groups that they have joined and access the map tool. These are exclusive functions for registered users.

Activity 3a: Groups

3a.1 Now that you are logged in at the Aquaknow.net KMS, please locate the group "Aquaknow Sandbox" and join the group.

On a scale of 1 to 5 (1 being least favorable and 5 being most favorable), please rate your experience in terms of:
Finding the group "Aquaknow Sandbox" in the Aquaknow KMS?

1	2	3	4	5

Participants felt that it could be useful to have two tabs for *groups* and *members* on the homepage instead of *community*. A *groups* tab should be made very visible. The sandbox group could have an *events* tab instead of *upcoming events*. This would allow users to scroll up and down to past and future events. Past event information is available in the *activity* function but this is confusing for the user.

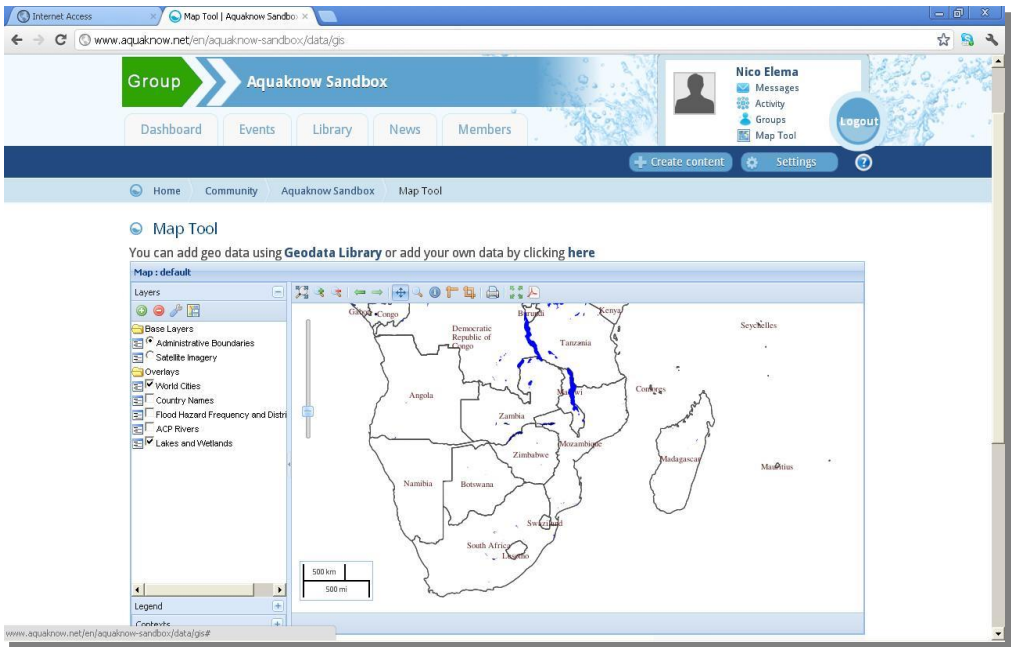
3b.3. Create content such as adding a document in the "Aquaknow Sandbox" group.

On a scale of 1 to 5 (1 being least favorable and 5 being most favorable), please rate your experience in terms of:
Finding the functionality to create content on the Aquaknow KMS?

1	2	3	4	5

Participants were not able to delete or edit content.

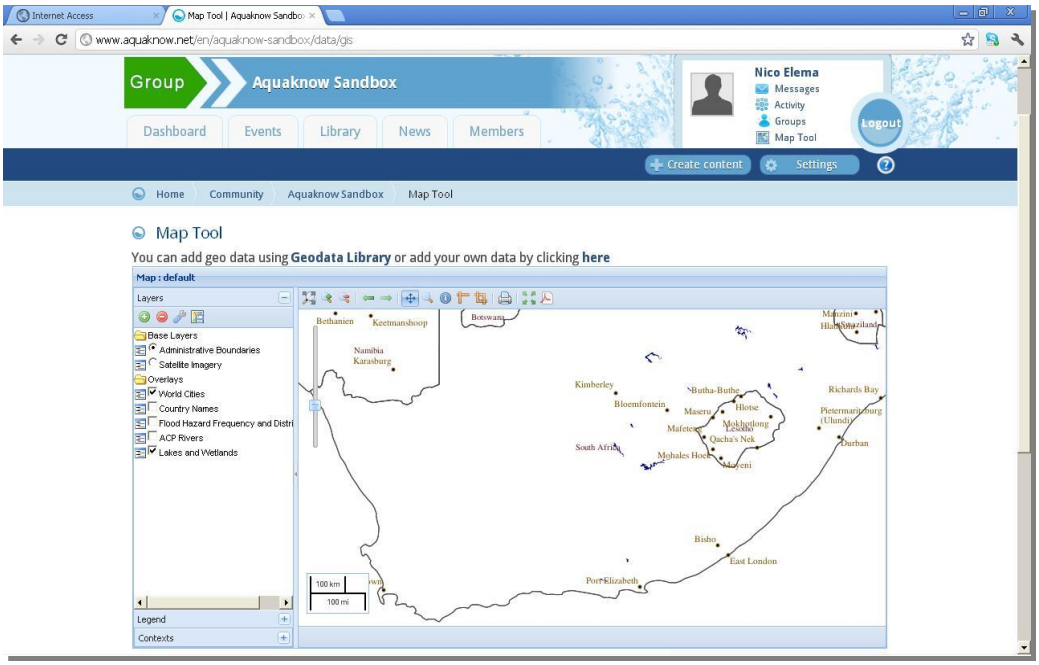
Map function (maptool). The functionality for linking into the map tool could be much bigger but in general the map tool was found easily. Users were able to perform the 'helicopter' and 'plough' exercise (see discussion in previous section) by zooming in and out of the map. Base layers such as *administrative boundaries, satellite imagery* are available. If a user wants to add data they need to access *geodta library*. RECOMMENDATIONS: Maptool – overlays should be separated from Base Layers as these require the Geodata Library access. This instruction is not clear. There are many layers including: *world cities, country names, flood hazards frequency and districts, rivers, lakes and wetlands*. It was difficult for people to grasp the concept that they need to go into the *geodata library* to access overlays. It is risky adding one's own data although, as this is a highly specialized function it is unlikely that the average user will want to add data.



Screenshot 3: Map Southern Africa

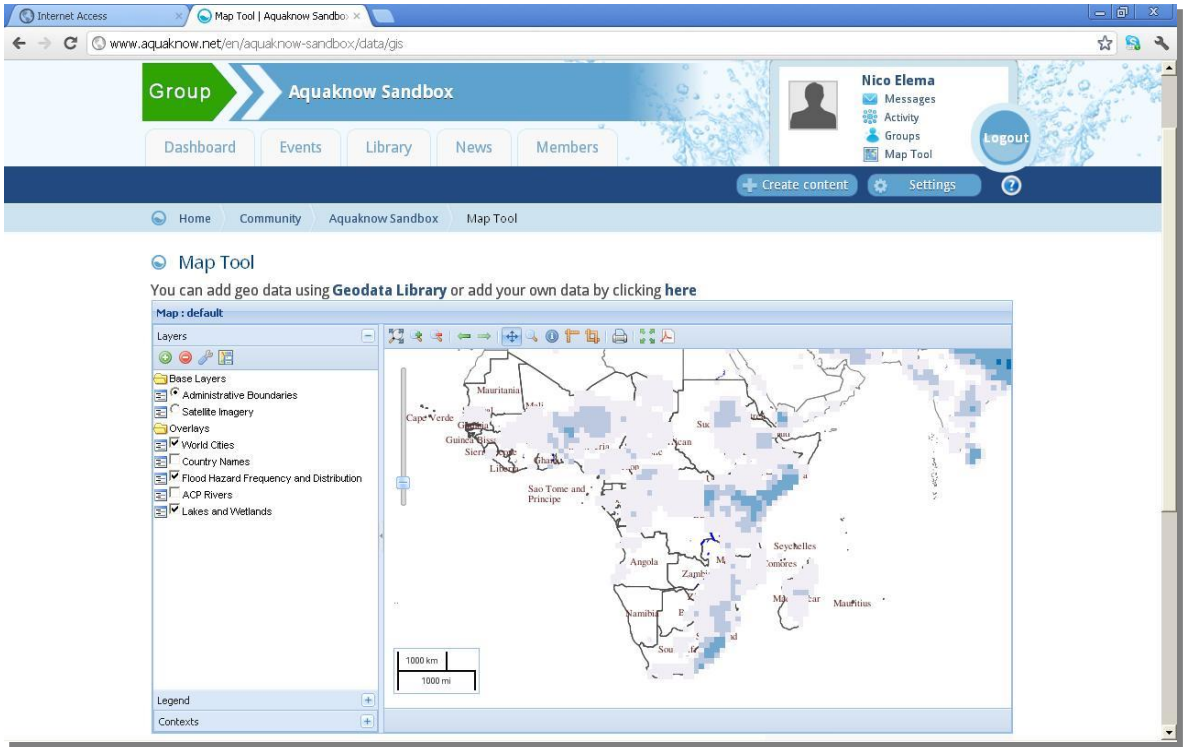
The second screenshot from the map function is Screenshot 4 shows a map of wetlands in South Africa. The map is not very populated and there are many more wetland areas than indicated. As this is a user driven content management system, a user who is interested and has scientific information that can be plotted can add more content and this layer

would then reflect the wetlands in the country more accurately. By showing the 'empty' map, the informed user can see that the content is not reliable and that, to make it more reliable, the user herself/himself must actively engage with the function. As Aquaknow becomes more familiar to Regional specialists, users can 'grow' the data, for instance, by inviting GIS wetland (and other) specialists to populate the map.



Screenshot 4: Map showing wetlands in South Africa

The following screenshot shows food hazards in Africa.



Screenshot 5: Food hazards in Africa

By adding a layer on food hazard frequency and distribution the user interested in the topic of vulnerability to food (climate change or other) has access to data. Again the current map needs to be updated and managed by a user who has scientific knowledge on this particular topic. Flood hazard frequency and distribution is through satellite imagery and it provides a fairly coarse picture of Africa and food hazard frequency and distribution. It shows flood hazards in Africa and although the maps need to be much more fully populated, some interesting information is quickly apparent; in this case we see that the Western part of Southern Africa, (Namibia), is not susceptible to flood hazards. The map tool is powerful and with the layer functionality it allows the student, researcher, planner to interrogate a number of specific topics at various scales and localities.

4.2 Zoom to South Africa, and activate the layer "Lakes and Wetlands"

On a scale of 1 to 5 (1 being least favorable and 5 being most favorable), please rate your experience in terms of:

Finding the GIS layer "lakes and Wetlands" in the Aquaknow KMS?

1	2	3	4	5

Although the map tool is powerful, unless one is fairly agile in navigating through a content management system of this nature, it is not easy to add layers. Most participants were able to find the map tool functionality quite easily but when invited to activate the layer

lakes and wetlands, all participants found it difficult to so. The layer tab on the left hand side of the map tool did not provide this option.

Content: The users were invited to search topics of interest to them (example question 5 below). Topics included: fracking, rainfall, water supply, climate change, wetlands, rain water harvesting, food and water. The general comment on all of the topics was that there was not enough reliable and up to date information. Fracking for instance had only two articles. Wetlands, on the other hand, had 63 articles. The map did not have adequate wetland information. The wetland information did not have scientific articles that were relevant to practioners and researchers working in Southern Africa.

As the CMS is user driven, users should have the option of a user friendly walk through tutorial so that it is very clear how a user can add content. There should also be deliberate messaging throughout the site. A message such as *if you know anything about wetlands in your region please add content or update on wetlands*.

Groups: a group named Aquaknow Sandbox was created so that dummy data could be loaded into the group thus avoiding contaminating other sites. This allowed the user to *upload document, image, link, video, event and news*. Other functions include *features, edit, and archive* but these can only be activated by the group administrator. This is a good safeguard and it maintains the integrity of the content.

Most respondents were able to find Sandbox easily although some had problems finding the group. Once again a short training would be helpful. Video tutorials should be function specific and include topics such as: how to find a group, how to register, how to add content, how to edit content. The user would benefit from the tutorial most if it could be 'paused' and the functions tested while the video is still visible.

Title	Agency/Provider	Data format	Link & Files
SEDAC: Socio Economic baseline dataset		xls	Link
Joint Monitoring Programme (JMP) for Water Supply and Sanitation	WHO/UNICEF	csv xls	Link
UNWAIS	UN-Water	formats for text edition	Link
Mediterranean countries database		xls formats under spss software ; sav,spo pc axis	Link
World Bank database	World Bank	xls xml	
UN-DATA Database		xls xml	
Gapminder - list of indicators		xls	Link
OECD: QWIDS Query Wizard for International Development Statistics	OECD	csv	Link
SADC hydrological Map and Atlas	SADC		Link
Atlas of the Biosphere		satellite image	Link
SPLASH Partner-funded Programmes	Splash initiative	pdf	Link
EU Water Initiative Project Database	European Union Water Initiative		Link
Euro-Mediterranean Information System		pdf	Link
World Bank Database on Water	World Bank	formats for text edition	Link
CAZALAC			Link

The table above provides details of databases that are available on water related issues. These are not available on the Aquaknow site but there are links to the sites where these are available. It would be to the advantage of the user to have the data downloaded onto the Aquaknow site, copyright permitting.

Another example of access to hydrological maps and atlas follows below: http://www.aquaknow.net/en/database/sadc-hydrological-map-and-atlas.

However, this link does not give the atlas – it only provides links and reference to it. This is helpful but it would be to the advantage of Aquaknow to set itself as the provider of maps – through copyright from SADC. In this way Aquaknow users could access data that is already in the public domain. It takes too much time for the user to access the Aquaknow site and then to spend more time login in and looking for maps that are not directly available on the Aquaknow site. These issues become pertinent in developing country contexts, particularly in the SADC region where bandwidth and speed means that downloading is costly.

Library function: the drop down menu includes library access through the following link: http://www.aquaknow.net/en/library. It was frustrating for most of the users who were consulted to access the library because there are very few reference sources that can be classified as truly scientific. Some sources are annual reports that are in the public domain and these are helpful but it would add value for users to post scientific articles that are of interest to stakeholders. The site also requires some policing as a barrier to posting because currently the library page includes advertisements for jobs, vacancies and funding opportunities. The site would need to have a separate page that contains data of this kind. The category *agriculture and food* that is on the library page was opened. There was very little scientific knowledge filtered through this category and here again, the page had been used for advertising products.

Overall, Aquaknow can play a significant role in the SADC region by providing the technology for people to interact with, and in so doing to build the kind of databases and sources of information, with comments, scientific discussion and considered 'opinion's that open wide debates on contested and important issues in the region. The site is currently providing useful information on events that are taking place and has an up-to-date calendar. As a CMS, this tool needs to be sharpened and then used regularly so that the site becomes embodied and reflects the talent, challenges and opportunities open to SADC water sector stakeholders.

These are already a few options inviting the user to interact and to use the knowledge management system. The most recent newsletter was very informative. It gave feedback on the Latin American Centres for Excellence Network and announced the set-up of the Southern Africa Network for CoE. The database is constructed using a navigation system that is fairly simple. It starts with the 'helicopter' view and then goes into 'ploughing'. The helicopter maps its way using thematic areas and geographic area to define categories on contents. This assists in finding both stakeholder partners (people or organizations) and particular thematic working groups.

Section 6: Conclusion and Recommendations

Content Management has appeal but is a hollow vessel unless there is uptake from partners. The technology is only as good as the people who use it – and vice versa. A content management system pivots around technology and users (people). In considering the advantage of a robust Content Management System, such as Aquaknow, as a tool for building capacity and partnerships for the NEPAD SANWATCE member countries, the following questions are pertinent:

- **What do we want from the database?**
- **How can we get the sector to use the database and become contributors to Aquaknow?**
- **How do we link with other systems and what is our comparative advantage?**
- **Who will evaluate the CM system?**
- **How do we manage complexity, ethics, integrity, security and diversity?**

The conclusion will take up each of these questions, proposing ways in which these questions can frame responses from the sector and bring about discussion, dissent and debate. These questions present a critical focus point for discussion by sector wide partners and the points raised below are by no means conclusive but offer some preliminary responses to these important issues. Further research is required to answer these questions and this is iterative. These are question that can be asked regularly as the requirements for the use of data for the sector changes over time and the requirements of users themselves change as they learn what works and what does not work for them.

6.1 What do we want from the database?

The report has examined the advantages of a CMS and proposed certain criteria that are essential ingredients for the desired system. We want our CMS to be 1) relevant, 2) accurate, 3) reliable, 4) interactive, 5) valid and 6) simple. Importantly, it must have *clarity of objectives and quality of design*, remembering that there are constraints and an uneven capacity for retrieving relevant content, the content must be contextualized and practical. There needs to be *long-term engagement* where data accumulates and is able to take on complexity and change and it must be able to reflect changing physical, natural and social environment, taking on board changing and new ways of thinking and doing. The system will depend on *ownership* by the SADC community of water practice. Through this ownership it becomes a connector to sector partners as a fabricator and mediator of data for uses and users in the Region. Finally, our system will have the quality of *participatory*

diagnostics which implies the capacity of the users to assimilate, interpret, use and construct new knowledge in a cyclical and organic way in the service of the natural and social environments on which citizens in the SADC region depend.

6.2 How can we get the sector to use the database and become contributors to CM?

This is dependent on three of the four points highlighted above, clarity of objectives and quality of design, ownership and participatory diagnostics. The regional workshop that is planned for August 2012 in Botswana, is an opportunity to further bed the CM system for users in the Region. If contributors find that relevant, accurate, reliable, valid and simple content is there within the system and that the system operates through interaction, contributors will see the advantage of sharing content and of having such a repository. The incentive for users is that this is 'their' tool and that they populate and use it for their own needs.

6.3 How do we link to other systems and where do we fit in?

There are a number of powerful content management tools in the sector but many of these are specific either to a country or to a topic. Some databases, in particular those linked to the CGIAR International Water Management Institute, are global in reach and share broad spectrum important water related science. Our own system will be linked into existing content management systems. These are repositories of content that add value to our system. Global CM systems, such as that belonging to CGIAR or the International Water Management Institute (IWMI) are managed and owned by the parent organizations. The NEPAD SANWATCE CM system, Aquaknow, is only partially owned by parent organization but ownership lies with the partners themselves. The comparative advantage of Aquaknow is its ability to store, manage, disseminate, nurture and generate data for the Region and beyond. This CMS is a tool that is a scaffold for the SWAp. It is **the** central tool on which the NEPAD SANWATCE pivot. CGIAR's programmes do not depend on the existence of a database. CM systems such as the CGIAR one, capture programmes and deposit content of CGIAR activities, projects and programmes. As is the case with a CM system that has integrity and its users interests at heart, Aquaknow has links to all relevant CM systems that can offer practical action for the natural and social environments in which our users operate but it is not programme driven nor is it organized by the parent organization. Content is user driven.

6.4 Who will evaluate the CM system and consider its strengths and weaknesses?

There are two stages to the evaluation of such a system. The first is internally where partners are invited on an annual basis to evaluate the uses and users of the system and suggest ways in which the system can be adjusted or revisited so that it best serves the region. The system will also be evaluated by an external consultant. This presents an impartial evaluation that will assess technical aspects such as 'hits' and 'likes' and the profile of users who traffic through the system. It will also be evaluated against the recommendations put forward in this report.

6.5 How do we manage complexity, ethics, integrity, security and diversity?

This question is at the crux of the theoretical and practical arguments that frame our inquiry. The key word here is 'manage' and our management style must be such that it invites openness, transparency, accountability – principles of good governance. We need also to be vigilant to the idea reflected in the 'clock' model presented above. This model takes cognizance of different types of knowledge, reminding us that tacit knowledge requires appropriate tools (videos, storytelling etc.) to bring it to the surface so that it can be shared with users. Because of the diverse users Aquaknow requires the right mix of science, innovation, ideas, abstraction, conceptual thinking, technical expertise and practical knowledge. The ethical issue is to be vigilant so that cultural and mythical experiences and locally embedded facts are profiled. The users will put these stories into the system but the onus is on the administrator to make sure that it is easy to so. Care in adhering to the principles of reliability, validity, accuracy, relevance and simplicity will maintain the integrity and security of the system. The administrator and users must be reminded to be vigilant to threats to the integrity through ambitious users who seek to manipulate the system for their own gain.

The final paragraphs of this conclusion draw attention to the main points that have been made in the discussions above. A content management system is represented by a collective of data and tools that allow the user to work with data in analog form. Management of the CMS for the NEPAD SANWATCE needs a high level of ethical wisdom. The shift is away from simply focusing on the end user, to a focus on ethical about how data is codified, stored, managed and disseminated. To be more than just a means of collecting information and establishing technically sound systems the science (data) and the technology (functions and balance between explicit, tacit and implicit data) should be aligned with user needs and the needs for water resources management in SADC and beyond. The system, because of its interactive nature and because sector partners themselves populate the content, is likely to have bias. Bias is an advantage because it adds thought-provoking value to the repository within which bias resides. The existence of

various biases on any one topic is an advantage because it fosters investigative thinking - the root of problem-solving for water related issues.

As the water sector is a knowledge intensive sector, the focus on data management is not a 'nice to have' but a 'must have. The impact of the CM tool is not inherent in the technology but largely depends on the way society uses the technology. Importantly, the development of knowledge is a *process* of conversion of innovation ideas and water related science into action and goods. The philosophy behind Aquaknow is overtly normative – data is there so that the lives of people and the natural environment on which they depend can be bettered. There is a healthy tension between the quest for 'pure' science and the requirement for practical solutions and interventions. The system will maintain equilibrium between science and society because it is a self-regulating tool. If the ideas are too technical or 'scientific' they will have no appeal to the users and the system will reject them – they might be stored but they will not be used. The system is the fabricator as well as the mediator of content for practical purposes.

Content management is antecedent to environmental management and sustainability. A good CMS should be able to sustain a competitive advantage over other CM systems by developing its content assets interactively. The performance of individuals can be traced by their remarkable ability to adjust, adapt and learn but this agility and adaptive capacity depends on the content at their disposal. It is within the *ecosystemic ethic* that we see the true value of CM, its potential for simplifying complexity and facilitating interconnections. No one aspect of a system stands on its own. A good CM system will deal with complexity and facilitate practical working relations between different parts of the whole. Healthy eco-systems are learning systems that adjust and adapt to new stressors or benefits that enter into that system. Aquaknow will be very much the same. It has the potential to regulate users who enter knowledge, retrieve it, disseminate, interrogate and use data, and as a complex and interactive system it is likely to foster good judgment and help build the qualities of users to interact, retrieve, disseminate and interrogate data. Users in the Region and beyond learn from the CM system and the system learns from its users.

Although there is value in science for science and the quest for data, with the urgency of problems that face the globe in the 21st Century in general and the SADC region in particular, unless there is uptake of science, the ideas and innovation might just as well not have happened.

6.6 Detailed recommendations from evaluation

A. EVALUATION

- Site stats as on the 24th April 2012: 7992 contents (posts), 159 comments, 15 public groups and 790 users.

- Internet penetration and usage is uneven across developed and developing country contexts – and is also varied within countries. Connection can be through a phone, a tablet or PC. Private access is limited to households who have adequate income to purchase their own PC and for the low-income groups PC penetration is expensive and unreliable. Many people who do have access complain about unreliable access – the costs are high or/and there is limited band-width resulting in data download that is slow.
- Evaluation of Aquaknow users should not be about physical access but rather about differentiated online skills. Focus should be on why some users are able to add content, use and manage information and others are hesitant, unwilling or unable to do so.

B. STRATEGY

The first step is defining the CM Strategy. This includes making decisions about trade-offs and having a unique value about what Aquaknow is and what it stands for. The following properties can be written into the strategy and these properties should be visible to the user:

- User driven: The interrelationship includes the way that content is stored, protected, managed, controlled and used.
- Ethical normative value driven system
- Science for society
- Self-regulating – if ideas are too technical or 'scientific' they will not have an appeal to the users and the system will simply reject them because they will be stored but not used
- Fabricator and mediator of knowledge for practice
- Data to be defined as almost anything: documents, movies (video clips), texts, pictures, phone numbers, articles etc. The power of a system that stores a wide range of data, codified in different forms, is that it can capture tacit knowledge and make it explicit.
- Consultative

Key principles for a CMS include:

- As a community of practice develops around the NEPAD Centres of Excellence, new learning will take place as users retrieve, reject, recreate and manage new 'facts' around water. The system should be resilient to change as it takes in new learning and new learning brings change into the system.
- With the additional uncertainty and risk that comes with climate variability and environmental changes, particularly challenging for the water sector, we need to think and work together in larger communities of shared information, and co-ordinated action.
- The political aspect of promotion is important when dealing with countries in the South that has a history of colonialism and disadvantage. Aquaknow would be especially appealing with an emphasis on being a CMS 'for the people and with the people' promoting the user driven aspect of the system. This marks Aquaknow as a consultative tool that bridges cultural, geographical and socio-economic divides.
- Knowledge is institutionalized and it becomes legitimate because it results in institutional learning. According to Turton (2002), the difference between information and knowledge is

the process of legitimization. But, what is more important is to look at how some who are online are able to use the medium while others are not – in other words differentiated online skills. More research is needed in this regard.

C. UTILITY

- Promote the relevance of Aquaknow as a tool for bringing science to the people, bettering society and natural environments through technology (its functions).
- Promote the idea of multiple realities as an incentive for users to bring their way of seeing things into the space. Different frames of reference strengthen the validity and accuracy of content.
- Create functions and walk through video tutorials so that different types of content (stories, pictures, video clips and so forth) illuminate tacit knowledge. The paradigm that we are lodged within – our own way of seeing the world – determines which facts we manage, and how we manage and share them. This is an ethical issue and Aquaknow can promote its property of ethical management.
- Although there is value in science for science and the quest for knowledge in itself is worthwhile, with the urgency of problems that face the globe in the 21st Century, we want to encourage the uptake of science. This is an incentive for users to come to the site, look for relevant science, interrogate it and learn about how the science can better society and nature

D. CHARACTERISTICS

- Aquaknow should be characterized by four properties: clarity of objectives and quality of design, long-term engagement, ownership and participatory diagnostics
- Aquaknow to support these four characteristics because the data has the fundamental principles of 1) relevance, 2) accuracy, 3) reliability, 4) interactivity, 5) validity and 6) simplicity. One cannot control for accuracy, but Aquaknow can assess accuracy (evaluate) through the number of hits that shows that the content can be trusted. The reliability tells the user that they know they can find what they are looking for. We know the system will be interactive and that it can tolerate feedback loops between users. Valid data reflects reality. The simplicity of data means that non-specialized water sector users can understand the content.
- Broad and narrow characteristics: the system must be able to settle on deeper specific facts but not lose out on the helicopter view either.

E. CONTENT

- Contributions/opinions to issues that open wide debates on contested and important issues in the region. The site is currently providing useful information on events that are taking place and has an up-to-date calendar. As a CMS, this tool needs to be sharpened and then used regularly so that the site becomes embodied and reflects the talent, challenges and opportunities open to SADC water sector stakeholders.
- Out of the box – incentives, best story of the month. Circulating emails – do you know
- Chat facilities – social media on Aquaknow – your water corner – water meets health; water meet education; water meet tourism promotion of inter-disciplinarily.
- Follow four dimensions of social learning for sustainable development: 1) seeing connections 2) relating functions to one another 3) making use of diversity and 4) creating synergy.

- Think ecosystem - ecosystemic ethic – its potential for simplifying complexity and facilitating interconnections. No one aspect of a system stands on its own. A good CM system will deal with complexity and facilitate practical working relations between different parts of the whole by having the right menus, linkages and functionalities and by having user friendly walk through tutorials that help the user access different components of the whole.
- Ecosystemic ethic – social learning, People learn from the CM system and the system, through hits, comments and so forth, learns from people.

F. FUNCTIONS

- As the CMS is user driven, users should have the option of a user friendly walk through tutorial for every function, however simple it might seem. It must be very clear to the user how to add content, delete content, access the navigator toolkit, the library, and join a group and so forth.
- 'Hitting' and 'liking' have become powerful means of increasing the responsiveness of certain items. An online content management system thus adjusts the prominence of items within its content according to the 'hits' it receives on specific items. It learns what its users want, what the current social and environmental issues are at multiple scales, not only from the interaction in comments or contact emails to the server but by simple hitting on certain items: It achieves this by producing a very specific, goal-directed repository – the intent being to contribute to solutions of specific problems related to the water sector.
- In focus functionality appears to be a fairly arbitrary news function. In focus could be more specific and focus on headlines across the globe on water. Community members from the different groups will add value to the in focus site once they recognize its use and should be encouraged to post documents, latest news, upcoming events and latest data. A larger font saying 'post here' and 'share your news' would encourage users to add content to in focus.
- Adding one's own data requires specialised skills and the everyday user will not be able to manipulate this functionality. Aquaknow to consider a similar approach to 'openstreetmap' (www.openstreetmap.org).
- Users to be encouraged through clear signage, for instance: 'if you know anything about wetlands in your region please add content' / 'update on wetlands' / 'do you know a wetland expert who can add value to this map?'
- Useful to provide options for entering data that has broad categories such as the WARFSA project on WDM does, commercial data, network data and mission specific data.
- Aquaknow to consider advantages such as those on Wikepedia – a free encylopedia anyone can edit. This legitimizes the data as people add data.
- Make links between Wikepedia and other as user driven web spaces.
- Creating content function within the sandbox: you are guided through required fields. One can edit and view the entry. It is helpful to have a delete function so that one can manage the content. Creating content is fairly easy but each function (such as this) would be greatly enhanced by having a short tutorial video for first time users. A BIGGER group icon would assist in finding it.
- Post user friendly walk through tutorials ….*see url.*

- The fluidity of the linkages allows for different components of the system to interconnect and this agility percolates new knowledge as the 'old' changes meaning and becomes a novelty. Use WORDS CHANGE, NOVELTY AND SO FORTH.
- Create a delete or edit content function (if it exists, it is not very visible).
- Do not use acronyms that are not defined. Links to specialised sites would be helpful to find definition of key words and concepts.
- Communicate with users (see com_doc JP) not just about updates but about user profile – no of hits, countries accessing and encourage users to 'fill in the gaps'.
- Use questions developed by Schmidt and Stork's (2003) Stock on e-readiness or e-skills.
- Some functions can only be activated by the group administrator. This is a good safeguard and it maintains the integrity of the content.

G. NAVIGATOR TOOL KIT

- Navigator toolkit is a powerful and highly specialized tool. It would be helpful to have a 'walk through on-line user friendly tutorial' that goes with this function. The existing tutorial is not sufficiently user friendly.
- The tutorial needs to be more readily available – standing out clearly for the user.

H. LIBRARY

- The library function is of critical importance because this is the place for the uptake of science. There is uneven content here, for instance 63 articles on wetlands but only two very mediocre postings on the topic of fracking. The 'science' available in the library on wetlands makes the lack of data on the map on wetlands even more visible.
- Library function: the drop down menu includes library access through the following link: http://www.aquaknow.net/en/library. It was frustrating for most of the users who were consulted to access the library because there are very few reference sources that can be classified as truly scientific. Some sources are annual reports that are in the public domain and these are helpful but it would add value for users to post scientific articles that are of interest to stakeholders.
- The site also requires some policing as a barrier to posting because currently the library page includes advertisements for jobs, vacancies and funding opportunities. The site would need to have a separate page that contains data of this kind.
- The category agriculture and food that is on the library page was opened. There was very little scientific knowledge filtered through this category and here again, the page had been used for advertising products.
- The IBNET toolkit includes a set of core indicators from which stakeholders can build their own customized measurement and monitoring system. The toolkit can be downloaded from http://www.ib-net.org/. See also ibnet@worldbank.org and www.iwaponline.com for a list of journals with information on the water sector.
- Useful to have an online library where one can also purchase books, with links to water section in amazon and other on-line reputable bookstores. Also where users can buy second-hand books.

I. MAP

- The map tool is powerful and with the layer functionality it allows the student, researcher, planner to interrogate a number of specific topics at various scales and localities. Maptool overlays should be separated from base layers as these require the Geodata Library access. There are many layers: world cities, country names, flood hazard frequency and districts, rivers, lakes and wetlands. It is difficult for people to grasp the concept that they need to go into the geodata library to access overlays. The layer tab on the left hand side of the map tool for findings lakes and wetlands is not easy to find.
- There is opportunity to add own data. When finding WMS wizard, it will not be clear what WMS (web map service) stands for, since many do not have a GIS background. It's a way of sharing GIS data but requires backgrounds in GIS. This is a powerful functionality but not accessible by the layperson.
- A further example of access to hydrological maps and atlas follows below:

  http://www.aquaknow.net/en/database/sadc-hydrological-map-and-atlas. However, this link does not give the atlas – it only provides links. This is helpful but it would be to the advantage of Aquaknow to set itself as the provider of maps – through copyright from SADC. In this way Aquaknow users could access data that is already in the public domain. It takes too much time for the user to access the Aquaknow site and then to spend more time to login and look for maps that are not directly available on the Aquaknow site. These issues become pertinent in developing country contexts, particularly in the SADC region where bandwidth and speed means that downloading is costly.

- Map example USER CONTENT DRIVEN – get the message that is your space, Fill it up. Talk to each other.

J. REGISTRATION

- The wording of create an account could be changed to register. Most of the participants agreed that the function 'register' would make a user feel more secure. Registration also helps keep track of members. Registration could be speeded up and automated so that there is not a 12-24 hour delay in receiving a username and password. Some users received their password quickly (within a couple of hours) but others receive their password several days later. Automation of the register function would be quicker. It is unclear how the registration process is being managed by the JRC and we recommend improvement in speed of registration. There should be an absolute minimum time lapse between application of and receipt of user name. The wording for 'create a new account' instead of 'register' can be misleading
- Inform visitors to the site who the scientists are – the CGIAR site informs visitors to the site that they have 'scientists working in over 100 countries' and they list critical issues that these scientists pursue.
- Enlarge font and access for login function username and password. Not small on right hand side of page but centre page and large font size.
- All functions to be larger font – 'click here to join this group' so that the user has quick and easy access for functions such as uploading files, joining groups, posting newsletters.

- It would be useful to have two tabs for groups and members on the homepage instead of community. The groups tab should be made more visible. Replace events tab instead of upcoming events. This would allow users to scroll up and down to past and future events.

K. SECURITY

- Security measures – avoid slanging matches. Have a place that is 'opinion' – perhaps red flag can be put up for users – this is 'red flagged' as it is opinion and should not be taken seriously? Knowledge is partial – make it more whole – add your bit) have shown that bias in individual items of knowledge can actually be an advantage, adding thought-provoking value to the repository within which bias resides. The existence of various biases on any one topic can be an advantage insofar as it fosters investigative thinking - the root of problem-solving.
- Hackers break through firewalls. High security checks needed.

L. TECHNOLOGY

- A couple of respondents logged in on their blackberries and it was faster.
- Links through *sms* - in Africa use cellphones to access internet.
- Quick loading options for cell phone access.

M. SPECIFIC POINTS

- Latest publications ….
- Upload content – not create content
- What are you looking for in a site like this: looking for water
- **BOLD LETTERS IN FUNCTIONS**
- No one found the layer lakes and wetlands with ease
- Environmental assessments – not much information
- E-mails to be group related – not to receive all information that floods email

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Abstract

The report is divided into four sections. The first section presents the objectives and then the background to this study. It includes a discussion on ideology, bias and security threats that face a content management systems. As e-skills are so much part of access, use and management of a content management system, the next section looks at e-skills. This section presents some elementary data collected in a small survey of experts in the SADC region. Section three describes some existing databases, selected for convenience, and then provides a substantial analysis of AquaKnow. This is a content management system that is proposed as a pivotal tool for building the Southern African Water Sectors of Excellence. Section four ends the reports with a conclusion and recommendations for the way in which a content management system can promote the SWAp for the water sector.

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