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Assessing the University of the Witwatersrand Rural Facilty (WRF) as a sustainability center

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CHAPTER 1

INTRODUCTION

The human race has the answers of how to close the gap between the developed and developing worlds. Science has the answers of how to combat climate change. In each instance implementation is what is lacking. The United Nations' call to action, in respect of implementation, is embodied in the concept of sustainability. Sustainability implies an ideal world: one where the problems like disease, poverty and climate change are resolved and all human beings have an equal chance of a good outcome for their lives. To get there will require a unified dedication and commitment by the entire human race over generations.

Considering the current milieu with great divides of wealth, power, quality of education and medical care, as well as ecological footprints, sustainability appears an impossible task. But, all things are possible, and each generation gets the people and opportunities to face and overcome their challenges. In the practical experience of the author, the WRF stood out as a place where sustainability was actively happening. The people at the WRF appeared to understand the challenges, and seemed to face the challenges in collaboration with other stakeholders and the community. An impression was made that the WRF is practically adding to the sustainability of the area. The idea of this study is therefore to measure the WRF's impact academically as a sustainability center, and to see if the author's impression was correct, namely that the WRF has practically moved beyond its formal role as a boundary organization and over time became an anchor towards sustainability in the community where it finds itself. Future relevance may be that the WRF may become a model to emulate in the process called sustainable development.

This study therefore examines whether the WRF is in practical terms sustainability in action. To make this assessment the qualitative method of research was used. The key research themes of relevance, legitimacy, and reliability as well as stake-holder involvement, and boundary organizations, were considered. Of particular interest were the links created through boundary organizations, which lead to better communication between the different sectors in society. In turn it was then examined if such better

communication leads to a more united effort to overcome common problems, resulting in enhanced sustainability, obviously relative to the specific circumstances of the community.

Climate change, as an increasingly important factor in respect of sustainability, is discussed. The need to address climate change pro-actively, calls for new ideas. Sustainability centers can serve as tools to measure and combat climate change. In this fashion sustainability centers can add value to the management of the effects of climate change, empowering populations to be less vulnerable and more resilient. As much of the effects of climate change are likely to be felt in poverty struck rural areas, such sustainability centers could become a base where the "action" is, for instance to measure effects, and to act as springboards from where to address problems hindering sustainability.

Chapter three considers the milieu of the WRF in relation to sustainability and current literature. The divides between the developed and developing worlds and the divide between science and politics are considered in depth. Sustainability is a major challenge in the area in which the WRF finds itself, where the effects of climate change on a high HIV poverty struck community, is already felt. Accordingly, over and above the academic considerations, this study uses the academic notions to see their practical effect in addressing a vulnerability crisis, as experienced by the people in the vicinity of the WRF.

Boundary organizations were analyzed to consider the building blocks necessary for the WRF to formally transcend from an academic boundary organization to a sustainability center. Considerations in the literature such as salience, credibility and legitimacy are discussed. In this way the design and architecture necessary to be a sustainability center were viewed from the angles of multidisciplinary problems, calling for multidisciplinary solutions, innovation systems and implementation models.

The results of the study highlight the factors considered as important in creating a sustainability center by using the actual experiences of interviewees. The discussion chapter takes the practical framework of the WRF and analyzes it against the conceptual

design of a sustainability center highlighted by the literature. The conclusion and suggestions call for a pro-active approach to sustainability.

CHAPTER 2

HYPOTHESIS, METHODOLOGY AND KEY RESEARCH THEMES

This study investigates the potential of the WRF as a sustainability center. The method followed was qualitative. In essence the WRF was investigated as a case-study according to the qualitative method. Ten knowledgeable parties with first hand knowledge about the WRF's activities and relevance in the community were interviewed. Interviewees were asked a set of closed questions and then invited to participate in a discussion on their replies to paint an in-depth practical picture of the WRF. This gave insight into reasons for their answers. In this way an understanding of the relevance of the WRF in respect of sustainability was gained.

2.1 HYPOTHESIS

"The WRF is in practical terms a sustainability center as defined by the literature."

This study asks about the relevance of the WRF as a boundary organization between science and policy, and if it as such qualifies to be coined a sustainability center. Alternatively, if its practices and relevance is as such, that with minor modification, it could be a "formal" sustainability center.

The questions, posed to interviewees as direct questions, tried to establish if in their opinion the WRF was a catalyst for science, being able to produce research which is salient, legitimate and credible, and as such, positively impacting sustainability in the region. The interviewees were encouraged to elaborate on their responses. In this way the reasons were established why they considered the WRF relevant. The interviewees could comment whether in their opinion the WRF has an ability to stimulate communication and multi-dimensional addressing of challenges in sustainability, such as climate change and health.

The free discussions with the interviewees explained why they considered if the WRF has a practical impact, or not, on the sustainability of the community it finds itself in. It was further investigated if the WRF practically produces investigations and research which enables decision makers to make choices with good outcomes in relation to sustainability of the community as well as of the eco-systems surrounding it. Climate change demands an understanding of the factors that influence sustainability in a changing climate. Examples are socio-economic and biophysical influences. An effort was made to ascertain the level of stakeholder involvement as this was important to ensure accurate feedback on issues such as the link between resource availability and vulnerability.

Of particular importance was an effort to make a value decision on the level of trust between the community and the WRF, and the result thereof was drawn from the free discussion following replies to the closed set of questions. The architecture of an ideal sustainability center was considered as a blue print to measure the WRF as a "sustainability center", metaphorically on the border between science and politics, but physically on the border between the developed and developing worlds. In essence such center must have receptors for knowledge into relevant human and environmental spheres. It must be sensitive enough to consider impacts. The next step was to see if the WRF is a catalyst which promotes information being meaningfully dealt with, thus building a knowledge-in-action system which can help bridge gaps and promote successful implementation models.

It was considered whether the WRF promotes boundary work practices which are inclusive, participatory and consider and include stakeholders, so that problems, which are relevant, may be uncovered, and policies developed, which are successfully addressed through implementation models. The impact of boundary agents linked with the WRF was briefly considered.

The investigations were based on the literature such as Cash et al. (2003), Clark (2007), Clark et al. (2005); Guston (2001); McNie (2007); McNie et al. (2008) and Van Kerkhoff and Lebel (2006). The summary of such works, by Dickson (2008), were used as a measure to consider the results of the study on the WRF as a sustainability center. Investigations included, but are not limited to –

A) The WRF's

* Ability to promote need based research, i.e. does research at the WRF take place which prioritizes as a result of communications, between decision makers and scientists?

* Does the knowledge which develops through the existence of the WRF mobilize better research aims?

* Does the existence of the WRF promote building knowledge in action systems, investigating what kind of boundary work builds knowledge that leads to action?

* Does the WRF through its existence assist researchers to learn from experience, and using it as a base, adapt and experiment because of their exposure on the border?

* Does it manage power and interests, i.e. can governance be forged and managed, that is, responsibly and accountably guide the choice of which problems are addressed, of which knowledge is used, and of which decision makers are supported through science based efforts?

* Is the WRF a catalyst towards implementation?

This brief investigation looked at the WRF specifically from the perspective of sustainability through the eyes of people who know the community and the institution. For a full investigation, a much wider and deeper study is required. For the purpose of this small study, only personal perceptions were gathered from the interviewees and measured against the literature.

B) The WRF as a public private partnership incubator, for instance, does the WRF's presence in the community it finds itself in, lead to boundary objects being created that are permanent "products" of the science developed there. Also, does the "products" live beyond the involvement of the academics that created such solutions?

Further, does it lead to greater interaction between those who create solutions towards sustainability through science, technology, knowledge creation and by such knowledge being shared beyond the WRF? Role players are widely identified as academic institutions, governmental organizations, society itself, commercial entities and other national and international institutions.

C) A and B above were achieved by interviewing a small sample of relevant persons. Interviewees were further encouraged to give their personal opinions freely and, if possible, backup their views with examples. The examples which were given by interviewees form part of the findings herein.

This study deals less with the formal and academic impacts, but rather concentrates on the practical impacts by the Wits Rural Facility (WRF) on the sustainability of the community it finds itself in. It thus asks the question if the WRF, through its presence made the society more resilient to deal with the consequences of climate change. The impact of the WRF on issues such as wetlands, water supply and sanitation, eco-systems, health, and better governance came to the fore during the research. It was asked what can improve the WRF's ability to add further to sustainability. Can it by research and interaction with the community, mitigate the effects of climate change? The vision is that perhaps in future a grid of sustainability centers, from where sustainability for a region may be managed, could assist with mitigation and adaptation of the effects of climate change.

Stakeholder involvement is essential to ensure good outcomes. Interdependence between population and the environment is becoming more pronounced. Implementation of plans such as the Millennium Development Goals also requires unity of stakeholder efforts to succeed. SACAN (Volume 17, March 2006) recommends area specific research so that scientists may assess what the true situation is in a specific area, simultaneously find solutions, and oversee implementation. UNEP in the 2007 Working Group II Technical Summary warns that the presence of other stresses, such as poverty and HIV/AIDS may compound the effects of climate change. The result is likely to impede the ability of nations to implement sustainability as measured through the Millennium Development Goals.

Affected regions require quality research monitored over time. Centers should be created to use as a base for long term research that would lead to continuity and accuracy. Such centers need to straddle the gap between the developed and developing worlds and need to incubate partnerships for finding solutions and assisting with implementation of

policies. A positive outcome would be early detection of climate change and mitigation of the effects thereof. This will lead to more resilient and less vulnerable communities.

The research was conducted by interviewing a small sample of relevant persons, including WRF staff, some from Agincourt Health and Population Unit, SUNRAE program &WRF, RADAR and other past programs, AWARD and the Forced Migration Program. Community leaders, educators, hospital staff and a civil society organization were also represented.

To obtain permission from the University of the Witwatersrand to do the research the standard ethics processes were followed. The necessary forms were completed and the necessary submissions made and accepted. I am deeply indebted to Mr Wayne Twine, Manger of the WRF who arranged the interviews and made his facilities available for a number of the interviews. Other interviews were scheduled at a hospital, a school and a community center. One interview was scheduled at a commercial center. There were no personalized questions asked and people did not bind their institutions, but were rather encouraged to speak freely so that their impression of the WRF as a sustainability center could be assessed practically rather than academically. Those who had been there for a long time saw the impact into the lives of the local community. They also told with pride how some of the programs and research originating from the WRF were implemented nationally.

The ethics process was followed by obtaining permission from the University of the Witwatersrand's ethics committee. Written permission was given by each interviewee. A further measure taken was to investigate the literature on the subject, as is set out below. The current literature commenting on boundary work was of particular importance to this study. This study aimed to assess the WRF's practical impacts on the sustainability of the community, in the superficial form of a pilot study. It accordingly is by no means a conclusive finding. The aim of this particular study was simply to assess practical perceptions of people on the ground how they perceive the WRF, what they see practically the WRF has done towards making the community more resilient and sustainable. Specific questions were asked and they were asked to give examples to support their answers. Such examples are described in the results of this research. The

results were not measured against the technical aims or purpose of the University. The reason is that this research is trying to practically measure the perceptions of the people representing the community as to sustainability, not the intent of the institution itself. The literature shows that where the true need lies is interaction with communities and practical improvement of their lives (or the failure thereof). This study tries to ascertain if the WRF fulfilled that need, namely interaction with community and practical improvement of the lives of the people in that community.

The notion of a boundary organization is defined by Forsyth (2003), as "Social organizations or collectives that sit in two different worlds such as science and policy, and can be accessed equally by members of each world without loosing identity." The WRF, as the academic institution may be viewed as a conduit, the structure as visualized by Guston (2001), whereas the effects of its presence needed to be considered, comprising of this research. Does the WRF create links in multi-dimensional communication? An effort was made to establish if the WRF promotes through its presence, and research such communications. Furthermore has its presence and it stimulating such communications resulted in transitions from scientific research to development of policies and implementation of such by government? Has its science translated into social responses? Is the WRF science at the boundary interfacing with communities, experts and decision makers, proving useful to science as Cash et al. (2003) demand? The results were important to identify the WRF's relationship to and necessity in sustainability in the community it finds itself in. In particular, the many failures to proceed from science to effective implementation led to an understanding that efficient linking of knowledge and action is essential for sustainability to follow as a result (Cash et al., 2003). Moser (2008) calls for social mobilization to elicit change. Is the WRF already a platform where mobilization has taken place to elicit change?

The main objective of the study was therefore to see if the WRF is science in action; practically researching on a multi-dimensional need-based level developing sufficient communication and multi-level linkages to have its research lead to useful solutions and sound partnerships in the sustainability process. Is the WRF a center which adds to sustainability?

2.2 METHODOLOGY:

Disconnects exists between researchers and practitioners, and accordingly when research is done on the boundary, regard must be had for "dilemmas, disconnects and distortions that may arise as boundary crossing issues" (Fielden, 2001: 17). It is further important to understand stakeholder issues and to draw attention to communication problems which are common at the border.

The question therefore arose as to how to identify a method by which to measure the WRF's effects on sustainability. Sustainability implies what affects all aspects of a community. How would one best ascertain the impact of the WRF which is so wide and far reaching, in practical terms? Stakeholder participation would be essential. It was therefore decided it would be necessary to take an honest sample of people deeply intertwined in the surroundings of the WRF in order to ascertain if the WRF has a practical and real influence on making the community it finds itself in more sustainable.

When one considers the circumstances of the WRF, these points to the qualitative method as a case study. Yin (1984: 23), defines a case study as "a research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between the phenomenon and context are not clearly evident; and in which multiple sources of evidence are used." In the current study, all three issues mentioned by Yin were applicable, in that an effort was made to look at the real-life impacts of the WRF. No clear boundaries are present, and a wide set of facts through impressions, and also tangible objects, needed to be considered in relation to the WRF.

In its simplest form the WRF is the rural campus of the University of the Witwatersrand. Semi-autonomous University of the Witwatersrand programmes operates out of the WRF. Such programmes fall under various schools at the main campus. The WRF itself does no research, but have personnel which participate in some of the research projects and simultaneously administer the facility. So how would one go about the research which on the face of it deals with a simple straightforward arm of an institution, but which by personal experience appear to have taken on a life of it's own, and a life with a

vital dynamic for the sustainability of the area it is in. It became clear, as wide a view as possible from each interviewee would be necessary. But who needed to be interviewed?

Conducting the current research on the WRF by only interviewing WRF staff, would be a too one-sided approach. As the research needed to establish the strength of the links between the WRF and the community, the community had to be involved. However, who has the mandate to talk on behalf of the community? The question was put to Dr Twine the manager of the WRF. Dr Twine and his staff worked with community members, the government, scientists nationally and internationally and from the university on various projects. Selecting only those would also give a slanted view. Picking people off the street could also give a skewed story. Dr Twine assisted to strike a balance and selected a mix of the different groups represented.

The book Qualitative Interviewing by Irene Rubin (2006), gives guidance as to choosing interviewees, namely:

1. They must have knowledge about the research problem;

2. One had to listen attentively;

3. Ask additional questions about the answers until one really understood the wider picture;

4. Keep an open mind to try and learn something new from the perspective of another;

5. Work together with the interviewee as a partner towards the same goal. The underlying philosophy of this model is to work together as partners rather than to see interviewees as objects of research. This was very easy to adhere to, as years of efforts towards implementation of policies in various fields opened the door for genuine interest and concern, as well as a common goal to find solutions to bringing about better societies.

Interviews were accordingly conducted with people involved with the WRF and the community it finds itself in. Most interviewees were working on the border between science and policy or the developed and developing worlds for a decade or more.

The direct questions which were posed were:

1. Is the WRF relevant in it's interaction with the community?

2. Is there a perception that the WRF is practically enhancing sustainability in the boundary community?

3. Is legitimate intent to enhance sustainability in the community expressed through communication and the conduct of the WRF?

4. Is the WRF reliable in the execution of the relevant legitimate sustainability interactions with community, i.e. is its efforts practically sustained over time?

5. Has the WRF, by its presence and efforts, enabled the community to be more resilient, to relevant stressors such as poverty and HIV? Is the community because of the WRF's presence more able to sustain itself into the future?

In science, the main methodologies after various changes in the field are qualitative or quantitative methods. (Batista, 2003). This author found quantitative methods alone failed to meet the challenges of science where the links between society and organizations are investigated. Achieving accuracy and validity is paramount. In some instances a combination of both methods are indicated. In a sense such combination was used in this research, in that interviewees had to give a "yes" or "no" to a specific set of questions (the quantitative method, coming to an exact result). However, the deeper meaning of the research, uncovering the underlying ability of the WRF as a conduit towards sustainability came from uncovering attitudes and information through the qualitative approach. Interviewees were therefore invited to discuss their answers in detail.

The main research method used was therefore the qualitative research approach method for social sciences. This improved our understanding of why the WRF is going about its business in the way it does, and how it practically impacts on the community it finds itself in. The qualitative method of research aims at smaller focused samples rather than larger random samples as used in the quantitative research method, e.g. interviewing, etc.

The conceptualization was that the WRF is a de facto sustainability center, but did the reality support this potential? Accordingly, in conjunction with Prof Vogel of the University of the Witwatersrand and Dr Twine (WRF) a design was created to collect data through questions which provided viewpoints, but then also opened the door for

providing wider information which could substantiate meeting criteria associated with sustainability centers.

The sample group in this study is small, about ten people. Interviewees were, as set out above, identified by Dr Wayne Twine. Dr Twine Manages the WRF and has been with the organization for about a decade. Gibbons (1999) points out that the current demand on science from a societal perspective is to produce science which can be relied on, improving knowledge and understanding. He highlights the importance of transparency and reliability of information. Dr Twine's long standing with the university and his deep roots into the community as well as first hand knowledge of the environment and society greatly assisted in guiding towards interviewing relevant people. The people interviewed are people linked with the WRF, or with intimate knowledge about the WRF, or those in the community interacting with the WRF. All parties interviewed had an in depth knowledge and understanding of the issues they were asked about. The research, accordingly, is producing knowledge which is "socially robust" as demanded by Gibbons (1999). Participants were encouraged to speak freely and expand on their responses. In this way, through these interviews, information was obtained which would not necessarily have come forward in a written questionnaire.

Silbey (2003) point out how qualitative research is celebrated for its flexibility and that prior design can be a "threat" to qualitative research. Interviewees were accordingly approached with an open mind and merely encouraged to expand freely on the direct questions answered, in support of their responses. A distinction is made between user centered and user participation (Salvo, 2001). The current study is not an end in itself, i.e., part of the research of the WRF, but rather uses the participatory method to comment and take a snapshot of the interactions of the WRF.

Gagne (1985) suggested changed methodologies to keep in step with changing times. Accordingly the systematic approach was taken, but with an open mindedness which invited additional information and support in respect of the closed question answers. An effort was made to remain value neutral and as Denzin and Lincoln (2000) suggested, efforts were made to engage participants more powerfully. Participatory Action Research makes the research more accessible to those being studied. Participants in the current

study were accordingly given a synopsis of sustainability and its value in assisting with the overcoming of future challenges, such as climate change. Siebenhuner (2004) made an effort to find ways in which to give meaning to sustainability science and the participatory approaches one can follow in scientific knowledge generation. It was regarded as important to strive for scientific objectivity in the process which invited participation to enable the evaluation.

Stakeholder engagement through consultation with focus groups is a tool to assess a situation. In some instances it is used to decide on planning, organizing and funding. Technocratic and bureaucratic approaches were modified by the Rio Declaration on Environment and Development of 1992, which demands public participation. The current study, accordingly, took a look at the WRF to ascertain if in respect of this boundary organization, (WRF) sustainability is being better achieved because of it's being sensitive to the community it is in. The themes of the study looked at sustainability despite climate change, the value of the WRF being on the border between science and practice and its ability to stimulate communication and better insights leading to better results.

The interviews conducted were accordingly long, one on one, as suggested by Silbey (2003). A wide range of information was gained and most of the key research themes were answered through the responses.

2.3 KEY RESEARCH THEMES -ASPECTS OF THE PROBLEM TO BE ASSESSED IN TERMS OF THE LITERATURE

The main research theme was to measure if the WRF, against the Cash et al. (2003) model, calling for relevance, legitimacy, and reliability and improving the resilience of the community, met this standard. The results chapter shows that all interviewees agreed it was the case and substantiated their answers. Such explanations shed light on some of the other key factors in assessing the WRF as a sustainability center, for instance, its ability to link knowledge into action, whether it enables those from different scientific disciplines to synergistically work towards sustainability answers and whether it enhances adaptive strategies. With the explanations the interviewees satisfied most of the answers to the other key research themes.

A closer look relates outcomes with the architecture of an institution, it considered how the WRF as a boundary organization functions, and its strengths and weaknesses. This research acts as a snap-shot being taken of the WRF in action. This picture is then matched to academic views on the issue, to see if it falls into our definition as a "sustainability center". Accordingly, considerations such as views regarding boundary organizations, sustainability and the effects of climate change were considered as important threads through the research.

As a simple measurement, the strategies to link knowledge and action as expressed by Miller (2008), was considered, as set out below:

2.3.1 BOUNDARY ORGANIZATIONS – LINKS TOWARD BETTER COMMUNICATION, ENHANCING SUSTAINABILITY

The themes regarded as important, are based on literature, and are:

Boundary organizations as sustainability-in-action:

1. An aim was to look at the WRF as 'sustainability-in-action' with reference to Dickson (2008). She points out that to narrow the gap between boundaries', such boundaries need to be more permeable. However, this can be in contrast with what politicians who wish to have control of the circumstances, want to see. This creates tensions on the border between science and politics. One of the aspects considered was therefore the WRF's ability to be science in Action, despite politics. As a key research theme it is therefore investigated if the WRF follow research strategies which link knowledge to action and stay focused?

2. Dickson raises further questions in response to the linking of knowledge to action. The questions posed by Dickson are:

2.1 Clarity of the boundary organizations tasks by reconciling the supply of knowledge with the demand for knowledge?

2.2 Does the WRF construct and manage hybrids, i.e. sustainability objects which have elements which come from both science and policy?

2.3 Does the WRF have the ability to create and maintain spaces between science and politics to the extent that stakeholders can function together yet step back into their opposite roles when necessary?

2.4 Does the WRF reflect on it's progress and adjust accordingly?

2.5 Does the WRF build capacity through it's presence in the community? This pilot study did not probe deep enough to answer all these questions in relation to the WRF in a meaningful fashion, but the next chapter highlights results which answering the questions.

Synergistic effects of working together:

Miller (2008) refers to his own work in 2001 where he described the border not as a fine line but as borderland. He now goes further suggesting the issue may be "greyer" than that. To get clarity he lays foundations for evaluation of boundary organizations, namely, to what extent the politics-science pathways synergize or link and let go. He further points out that value learning, i.e. learning from mistakes is very important. In similar fashion Miller (2008) calls for boundary work to reflect consistency, yet interact to the extent of constantly seeking better outcomes. This research theme of platting groups together for a purpose and then letting go is commented on in the results.

Importance of communication:

Vogel et al. (2007) suggest conceptualizing the science-practice interface so a better understanding of the intricacies of multi-dimensional communication be gained. In view thereof the authors further considered the importance of managing the process with this intricate communication network in mind. These authors also agreed that research must be relevant and use-inspired. Communicating with the lay public is another issue raised by these authors and they suggest various entry points for such communication such as institutional arrangements. They concluded that the above was not a simple task. The WRF is briefly commented on in regard to the themes raised by Vogel et al. (2007).

In assessing the WRF as a sustainability centre, in the form of an 'institutional boundary' organization, it needed to show it can facilitate communication between actors from the institution and from the community. Such parties may have different goals initially as the

institution as boundary organization and the community may have different view points as to what is important. It is clear from this research that the more society and the WRF communicated, the more such communication between them lead to more coordinated boundary management outcomes. An example is the initial needs observed in terms of Aids patients and the eventual outcome of medical projects geared to answer such needs. The interplay and tensions, practical applications, commercial influences,

governmental and de jure and de facto governance in a community, and in an institution, is shaping each other towards greater relevance in the case of the boundary organization and towards sustainability in the case of the developing world. This study shows that communication can lead to more effective science, knowledge, and technology transfer from the academic institution as represented through the WRF in its interaction with the developing world.

Communication between actors from the institution and from the community is essential (Moser, 2008; Cash et al., 2003; Clark, 2005; Vogel et al., 2007 and McNie et al., 2008). Parties may have different goals initially. It is visualized that communication between them will lead to more coordinated boundary management outcomes (Vogel, 2007). The interplay and tensions, practical applications, commercial influences, governmental and de jure and de facto governance in a community, and in an institution, are expected to shape each other towards greater relevance in the case of the boundary organization and towards sustainability in the case of the developing world. It is anticipated such communication will lead to more effective science, knowledge and technology transfer from the academic institution to the developing world. It should further assist in adapting to climate change (Pielke et al., 2007).

A top-down, centralized approach may be useful in the macro-scientific environment, because the development of science, technology and knowledge systems can be purely academically based and may develop without delays.

Such an approach failed dealing with certain phenomena, such as water regimes

in the United States and influences at a micro level where it did not always benefit those most vulnerable to environmental change, or empower decision makers at local level

(Cash, 2000). The WRF is accordingly measured as an interactive boundary organization sustainability center.

Ayensu et al. (1999) pointed out the need for knowledge at micro-level to understand macro-influences and outcomes. Effective science takes cognizance of the wider implications as well as local vulnerabilities, interactions and stresses and shares such findings widely to create a network of knowledge, with a multiple flow of information, a polycentric information network. Knowledge sharing between researchers and decision makers and interaction between scientists and decision-makers is therefore an important positive outcome of a successful institutional boundary organization, and the WRF is measured for its impact in such regard.

Enhancing collaboration:

A collaborative project including Harvard University and Arizona State

University asked the question: "To what extent does the existing boundary framework illuminate the role of institutions in the multi-party, power-embedded negotiations characteristic of efforts to implement science-based sustainability strategies in international development? How can the existing boundary organization framework be generalized to cover this important class of expert-practitioner collaborations in knowledge production?" In essence the question means: how does the science-practice dichotomy get streamlined inside a boundary organization? The other important issue raised by this question is the power-struggles which so often mar implementation of good plans and policies. This group included representatives from boundary organizations and it was pointed out that often "western" views need to allow practicalities of technology and science evolved at a pace relevant to the developing world. The essence as a key research theme in relation hereto is that the WRF's need to be considered in light hereof, whether it develops research agendas to face the challenges of its milieu.

Climate change:

A further important theme is climate change. The IPCC 2007 Summary for Policy Makers warns of climate change impacts that will affect populations and lead to loss of eco-systems and biodiversity, lower agricultural productivity and an increase in vector-

borne infectious diseases like malaria. They list the possibilities in responses to climate change: mitigation strategies like technology, adjustments to behavior, managerial strategies and adaptive policies. There is no certainty how effective the response strategies will be and barriers will need to be crossed to achieve success. The WRF is well positioned to play a significant role in the monitoring of, and formulating adaptation and mitigation strategies.

The ENSO phenomenon discussed earlier, made it clear Africa is highly vulnerable to climate change**.** Devastating floods and tropical cyclones experienced in 2000 reduced the annual growth rate of Mozambique from 8% to 2%. In 2000 the drought in East Africa drastically reduced Kenya's hydroelectric power output, resulting in a US$ 72 million emergency loan. Making decisions towards sustainability with such complex uncertainty has resulted in calls for some suggestions as to how to reduce the risks of climate change. Issues which require urgent attention are how to avoid water distress and food scarcity? How is health to be dealt with, especially when poverty struck populations are faced with 'shock' events, like droughts and floods?

Africa needs to join the developed world, but development must be adapted to climatic effects. The variability of the African climate system is as such that uncertainty created a lack of agreement on models (Vogel, 2005) and in the impasse millions are left vulnerable. Vogel (2005), points out how the socioeconomic influences has to be inter-related with macro-economic forces and socio-historic backgrounds. Often adequate governance is lacking in addressing issues at hand. It is often a crisis which brings to the fore weaknesses in systems, such as water shortages during drought periods, or stagnant rivers during times of drought becoming prone to the spread of cholera.

Cook (2003) points out that progress is required in the research of areas such as onset of rains, land and surface atmospheric changes, droughts in Southern Africa and flooding in East Africa. With such events infrastructure is lost, wildlife and tourism are impacted as in Kenya, for example, hydro-electric power affected, which in turn affects economies in their ability to function.

Making decisions are very complex in the face of the uncertainties of climate change. Future sustainability centers, of which the WRF is a practical example, may be an

important factor in assisting with decision making in the future. The main research theme was therefore to investigate what a workable sustainability center would look like on the border between the developed and developing and with the purpose of making the developing community more sustainable particularly in respect of climate change.

The importance of being where the action is:

Government agencies and mainly US University campuses have set up sustainability centers to enhance awareness to students and form platforms for local community interaction. One, the Kerr Center for Sustainable agriculture in Oklahoma, USA has been in operation for 43 years. University centers, such as those at Cornell, Sage, or Kansas University, are however in close proximity to its main campus inside developed regions. What makes the WRF unusual is that it is a center run from a developed part of South Africa, but located in an developing mainly poverty struck population. It is further on the border between science and politics and as in many instances researchers at the WRF uncovered needs addressed later via policy. Part of the "construction" of the imagined centre on the boundary of the developed and developing worlds, is therefore derived from the practical experience of the WRF in over twenty years. The WRF has a history of continuity on the border and some of the results show the value of this long term exposure and research, where results can be correctly interpreted, only because the researchers have first hand knowledge into the community of the past and it's influence. The outcome is hoped to be taken a step further as an ideal and show the difference between an imagined ideal sustainability center and the WRF's reality. Such instances will be pointed out in comments on the results.

Sustained presence:

Sustainability requires a sustained presence of boundary organizations, at least until the community it serves is truly sustainable. This is likely to require sustained funding. Long-term public private partnerships for projects truly leading to sustainability and assisting communities to overcome vulnerabilities, is visualized to be essential to the success of a sustainability center. Sustained goal orientated research into core activity areas related and interlinked with community in the wider sense, is further likely to be necessary to make such centers relevant.

To do this requires breaking with traditional frameworks of institutions being urban bound. The call for more credible science and practically useful information (Gibbons, 1999; Jasanoff, 1987) span nearly two decades, about as long as the WRF have been in operation. The impact of the WRF must accordingly be assessed in terms of the impact on the community in long term practical impacts to consider it's effectiveness in respect of sustainability and to use such information in the wider quest towards dealing with Global Environmental Change. Against the backdrop of climate change Hannigan (2006) urge conduct that will co-coordinate research from different social worlds of climate variation and their impacts, so that on the boundary social and political decisions which are relevant may be made and shared.

The rationale of the present study is therefore to expand on the characteristics identified by Cash et al. (2003) and taken further by Vogel et al. (2007) and Moser (2008). This study highlights a 'frame' which includes relevancy, legitimacy and credibility. The study also includes the foundations in a institutional boundary organization which are necessary to enable an investigation of some of the needs and influences in the society it serves. An attempt was made to comment on the 'practical functioning' of the WRF. This may assist other academic institutions motivated by the success of the WRF to open sustainability centers.

Cash et al. (2003) and Guston (1999) identified three characteristics of boundary organizations, namely 1) to negotiate the boundary between science and decision making; 2) to defined responsibilities and accountability on both sides; 3) the common use of boundary "objects", which is that which is useable on both sides. In this instance, with the WRF not being formally a sustainability center, or even a boundary organization, the study reveals: 1) what in practical terms are the boundaries, and then wider than merely science and decision making, but also having cognizance for the community, including the commercial community, 2) how is respect fostered and by whom, and 3) where does the various sectors which the WRF interact with, find common ground Where do these building blocks lead to? What is the ideal architecture of a Boundary Organization as a Sustainability Center? What are relevant issues to take note of at a particular time?

Embedded boundary agents:

Mitchell et al. (2006); Miller (2008) and McNie et al. (2008), mention the importance of the people involved in sustainability and in particular on the border in boundary organizations. McNie points out how often the key to success in sustainability, is trust and relationship. The author shows how often these embedded boundary agents are the links between knowledge and action in sustainability.

CHAPTER 3

LITERATURE REVIEW

3.1 Background

The South African transition to democracy in 1994 offered the country an opportunity to re-think its value system. The 2002 World Summit in Johannesburg further gave South Africa the opportunity to measure itself against world standards in respect of sustainability. It also helped South Africa to reflect critically on unsustainable sectors of its population. The time is therefore ripe for South Africa to seek better ways to deal with its realities and ensure sustainability for all its people. Sustainability related principles, such as health and housing, are even entrenched in the 1996 South African Constitution and is accordingly a duty of government to give to the people. This research was to establish if the WRF plays a meaningful role towards the goals of sustainability.

Cash et al. (2003) suggest that to deal with sustainability effectively, effective ground work, science and background data, is needed to consider historic environmental impacts, then to produce effective science on the current situation through boundary organizations interfacing between communities of scientists and communities of decision makers. The decision makers then formulate policies for implementation to deal with the problem and as such promote sustainability. Boundary organizations created on a needs basis, such as ENSO, forecasting in the Pacific region and Exclusive Economic Zones (EEZ), dealing with the management of fisheries stock were considered by these authors and they laid

the foundation of what is regarded the qualities a boundary organization should have. Further authors have debated the functionality and design of boundary organizations, so that sustainability may be served by their existence.

Sustainable development is dependant on knowledge (Guston et al., 2001). In action, it practically links those tasked with implementation of it's principles to the scientists producing the knowledge which guides it (Cash et al., 2006). Boundary organizations are becoming increasingly important as institutions which stimulate communication and interaction between science and practitioners (McNie et al., 2008; Vogel et al., 2007). To manage natural resources and societies in a sustainable fashion, it is visualized boundary organizations will increasingly be a place where diverse parties collaborate towards sustainability without losing their own identity (Guston, 2001). To put this research in the proper perspective, the following must be understood: there are many boundary organizations working on the boundary between science and politics. There are also a number of sustainability centers as boundary organizations mainly through universities at or near university campuses to educate and think about sustainability. What makes the WRF important is that it is an example of a de facto sustainability center living the concepts of sustainability on the ground. Sustainability migrated into existence at the WRF through the different academic disciplines uncovering needs over decades and mobilizing practical responses.

To cast a shadow over already complex sustainability issues, global environmental change appears inevitable. Global environmental change is predicted to be responsible for increased changes in climate in various regions of the world. These predictions were made in the full report on the impacts of global warming released in late 2007 by the Intergovernmental Panel on Climate Change (IPCC). The report warns that the effects of climate change will be felt sooner than originally predicted. Accordingly, wherever sustainability is to be considered, attention must be given to climate change. The WRF then, as an academic center linked to a major South African institution, the University of the Witwatersrand, may be an important role player in assisting South Africa to deal responsibly with sustainability and climate change.

Serious consequences, such as water shortages and reduced crop yields, are now predicted likely (Gianecchini et al., 2007). The IPCC report warned that Africa and the Arctic will bear the brunt of the impacts of climate change. Such effects will come in the form of more intense weather events and adverse effects on ecosystems. Up to 30% of plant and animal species are at risk of extinction in the event that average global temperatures rise more than 1,5C – 2,5C. The report points out that a 2C increase in temperature is not unlikely. In such event approximately 2 billion people's lives and livelihoods will be at risk in the relatively near future. The current threats of climate change due to global warming can accordingly seriously affect sustainability.

Sustainability is a requirement for perpetuity of human kind (Guston et al., 2000). Climate change can cause an even greater gap between the developed and developing worlds (McNie et al., 2008). This has led to prominence for the concept of sustainability to address these problems (Hasna, 2007). However, there is often a divide between science and those tasked to implement sustainability measures through policy and other methods (Vogel et al., 2007).

The concept of sustainability itself is in general terms, a phrase to encompass a value system believed to promote the chances for maintaining a certain state indefinitely (Blewitt, 2008). Before the threats of climate change, not all people were at a sustainable equilibrium. Poverty, lack of safe drinking water and sanitation, illness and lack of education are a few examples of what prevents societies from being sustainable even without the threats of climate change. Sustainability is not possible to be defined exactly (Becker, 2004) and there is no reason in this research to do so.

For the current investigation to simplify the concept of sustainability one merely needs to understand that certain elements are required to have a sense of certainty of survival for specific people in a specific region (Vogel et al., 2007). The area in which the WRF finds itself in, would even without climate change have an upwards battle towards sustainability (Oliver, 2004) and is therefore an area where people do not have such sense of certainty of survival. Apartheid "relocated" thousands upon thousands to areas such as the one in which the WRF finds itself. People exist with virtually no infrastructure or hope of employment (Thornton, 2002). The essence of this research is therefore rather to

establish if the Witwatersrand Rural Facility (WRF) is a center which produces research which is salient, relevant and continuous to the extent that solutions are found and forged into existence in conjunction with the community and other stakeholders, thus making the community less vulnerable in the circumstances it finds itself in.

It was global environmental sustainability, in tandem with poverty and concerns for health, which led to the United Nations developing sustainability programs. The United Nations created the Commission on Environment and Development to address the differing priorities between the developed and developing world. The report of the United Nations, "Our Common Future", was published in 1987.

By the time of the 2002 World Summit on Sustainable Development in Johannesburg, stakeholders for collaborative policy making and implementation were identified and eight Millennium Development Goals were adopted, amongst those being a goal for the eradication of poverty. The follow up to the World Summit in 2005 promoted collaboration between the sustainability "pillars" of environment, society (community) and economy. Institutions and culture are recognized as further pillars. This study comments on the WRF as a pillar in the society it finds itself in, and practical ways in which the WRF assist the community to adapt to and mitigate the effects of poverty and climate change, and assisting people to be less vulnerable.

As the increased effects of climate change set in, as predicted by the IPCC's, the relevance of the WRF is likely to increase. The WRF offers as a sustainability center the potential for assisting the region to adapt to and mitigate the effects of climate change. It can do so by local interactions and the continuity of its presence in the area, creating trusting relationships. (Earle and Cvetkovich, 1995; McNie et al., 2008). Important is its presence for research over decades, measuring changes against the past and reporting on resultant changing needs of the community. Cash et al. (2006) pointed out the importance of a long term influence. Important in relation to risk, as suggested by Vogel et al. (2007), is the presence of the WRF on the border, enabling it to alert stakeholders about new developments as they occur. In this way early warnings can reduce response time in shock situations and thus vulnerability. The WRF can, as is presently the case, be instrumental in finding solutions to the needs of the people in the region and facilitating

communication between science and practitioners. By monitoring results through research, the WRF can comment and as such assist with successful implementation of plans, policies and technologies. Such future research involving the overseeing of implementation models to adapt and mitigate is likely to play a positive role in dealing with the challenges ahead in respect of climate change.

The question in the current research is whether the WRF already plays the positive role of an effective communication and knowledge exchange facility between science and politics. Does the WRF, through the translation of such knowledge into action, improve the circumstances of its surrounding community to the extent that it can be coined a sustainability center? To be so, it will have to be subjected to scrutiny as a boundary organization with the criteria set by Guston (1999) and (2001), and Cash et al. (2003). This is discussed below in the section dealing with boundary organizations. Further considerations are sustainability measures, such as sustainability accounting and well governed implementation strategies. Sustainability accounting identifies needs and measures progress. Sustainability governance prompts implementation strategies (Shaltegger et al., 2006; Hak et al., 2007). This research looks at the WRF's ability to identify problems through research, prompt solutions through the development of strategies and technology transfer for implementation, and its ability to comment on progress of implementation. Schackleton et al. (2008) call for a 'long term vision' and an integrative framework and the WRF is considered in this context.

Douthwaite (1999) promoted the quality of life improvement concept. Such improvement is influenced by practical circumstances and human needs (Cross and Spenser, 2009). It is accordingly also commented on as the WRF's ability to be a catalyst for improved circumstances for the community.

For South Africa it is important to find workable examples of institutions which practically improve conditions for the poor. South Africa is an example of one country containing a developed world on par with most modern economies, as reflected in its position as 25th in the world in terms of GDP. However, South Africa also has a developing community. This part of the community was, at least in part, deliberately created through the apartheid system (Thornton, 2002). Apartheid favoured one group

based on race over the majority of the people in the country. The majority did not form part of Western knowledge systems as the favoured group did. Accordingly, even before apartheid, there were differences in levels of education, housing and employment. Apartheid was a system which widened this gap. This lasted for forty years and has had a profound perpetual effect on the community even to the present time (Oliver, 2004). Sustainability in South Africa requires a grid between the developed and developing parts of its population to narrow the gap (Vogel et al., 2007). The challenge South Africa faces is how to continue developing on par with the pace of the world and simultaneously develop its developing section of the population (Bierman, 2007). Forces such as population growth, shortage of land, grazing and wood resources, drought and weak governance of natural resources, plague the community (Giannecchini et al., 2007).

This gap, between the developed and developing worlds, as reflected so prominently in South Africa, is just a small example of a world-wide phenomenon of the same problem (Kemp and Martens, 2007). The United Nations Department of Economics and Social Affairs Working Paper (2006) predict 9, 2 billion people by 2050. The present 1,2 billion developed people (the have's) are expected to stay static, the developing (the have not's) are expected to increase by 2,5 billion in terms of the projection of 9,2 billion by 2050. Sustainability governance is therefore of the utmost importance to deal with the present day problem and a predicted enhanced problem in the future (Jasanoff, 2008).

Sustainability science needs to investigate ways in which to deal with the situation where about one quarter of the world's population as estimated by the UN Working Paper quoted above, will have to assist it self as well as the remaining three quarters of the then world population. This will need to take place despite the effects of climate change. The economic downturn of late 2008, expected to last through 2009, is likely to further adversely affect sustainability as there is likely to be less money to spend on sustainability projects.

Clark et al. (2001) in 'Our Common Journey'(National Research Council, 1999), discuss the challenges of reducing poverty while the industrialized nations retain current consumptive life-styles. They suggest: "The reconciliation of society's developmental

goals with the planet's environmental limits over the long term is the foundation of an idea known as sustainable development."

To achieve this collaborative efforts are necessary. However, Worku (2007), points out that integrated approaches remain uncommon. Research showing the exact status quo of situations on the ground is necessary, and it needs to be done in collaboration with those involved, for instance the developing and the poor (Clark et al., 2001). Solutions and policies on sustainability are mainly driven by the United Nations. The United Nations collaborate with institutions and governments, and lately business partners (Lebel and Clark, 2005). There is a great need for regional implementation strategies that work (Dahl, 2007). For implementation to work, the initial research leading to policies, must be accurately focused on needs and implementation monitored and measured (Jasanoff, 2008; Dahl, 2007).

This small research briefly highlights as an implementation strategy the use of institutions on the boundary between politics and science. In this fashion such institutions can comment on the success or failure of policies at an early stage. From such centers, research which is useful and legitimate, may be developed to practically address the needs of the poor and vulnerable, with the potential for follow-up, as called for by McNie et al. (2008). Coordinated and well planned, and carried through approaches can lead to sustainability in a region (Vogel et al., 2007). Combating climate change and poverty may take the shape of government policies implemented through local structures, or scientific technologies developed to products, and utilized as ways to adapt, mitigate and reduce vulnerability (Vogel et al., 2007). To do this would imply partnerships between governments, society and commerce (Vogel et al., 2007). This study of the WRF as a sustainability center touched on the potential of partnerships on solving some of these issues, but more research is required (Guston, 2001).

The complexity of our modern society challenges us to link science to decision making, and then to link science and decision making to the multiple levels of society (Cash, 2002). Degradation of human life and of earth systems is feared, if implementation of science, technology and knowledge is not sped up significantly (Miller, 2001). The International Council for Science (2002) (ICSU, Paris, France), for example, concluded

that science, technology and knowledge must be implemented for the notion of sustainability to succeed. However, where and how and when do you transfer this to communities far removed from access to science technology and knowledge? Pielke et al. (2007) call for new ways of thinking, especially if a changing society is to ride the wave of climate change.

For environments to be truly sustainable Moser and Luers (2008) call for deliberate interfacing and setting up communication networks. To do this, one needs to create institutions that effectively utilize knowledge and skills derived from Science and Technology towards sustainable communities (Cash et al., 2003). As Cash et al. (2003) points out, the critical component is to find a workable equilibrium between "knowledge and action in ways that simultaneously enhance the salience, credibility, and legitimacy of the information they produce" (Cash et al, 2003, p 8086).

The current main concern is global environmental change (IPCC 2007 Report). Below is set out some of the challenges experienced in the region, a review of traditional ways in which such concerns were dealt with. It is further a suggestion that the WRF as a sustainability center on the border between science and politics is an example of a valuable tool as a functional boundary organization towards sustainability of the region. This statement suggests that the call from Clark et al. (2001) for integrated approaches is being practically applied through the WRF as a de facto sustainability center.

3.2 The WRF – straddling the divides:

The University of the Witwatersrand Rural Facility (WRF) interfaces academically between science and politics and empirically between the developed and developing worlds.

In 2007 the Center for International Development at Harvard University hosted a Sustainability Science program where the intricacies of Sustainability science was considered such as how nature and society interacts and issues of resilience and vulnerability in relation thereto. A central question was how to balance human development and sustainability. A core question is how the relatively independent activities of planning research can be adapted into a more integrated model for sustainability management?

William Clark of the Sustainability Science Program at Harvard University and the moderator of the program (Clark, 2007), pointed out the importance for science to ensure it is aware what knowledge is needed, who can produce such knowledge, and what actions based on such knowledge will lead to positive outcomes. Clark pointed out the great divides between the developed and developing worlds and how the developed world relies on technology driven research whereas the developing world often relies on action driven research. Clark brought to the attention that as needs inspired science to concentrate on issues of military or health or agricultural interest, a need exists to concentrate scientific effort on sustainability (Clark, 2007).

This is in essence where the WRF currently finds itself. It is the rural facility of the University of the Witwatersrand and as such, various departments of the university use its facilities. It is however, in the intricate cross-over between science and policy. As such the presence of the facility in the community produces knowledge which is relevant and salient because of its location, and as unanimously agreed to in the results hereof. McNie et al. (2008) point out how professionals in a boundary organization become entrenched in both sides and then "straddle" the divides as "boundary-spanning individuals" and can produce science which is more relevant because of their level of understanding and intimate knowledge of the circumstance. An example is the research of Wayne

Twine and Lori Hunter on household use of natural resources after HIV/AIDS deaths in a family, especially if it was the breadwinner who died (Twine and Hunter, 2008). Having first hand experience of the trust in Dr Twine by the community members personally encountered, and spoken to in their own language, one is left with the impression the observations of Dickson (2008); Clark (2007) and McNie et al. (2008), that trust is imperative for in-action research, As such, those involved with the WRF for a long time, often a decade or more, have formed the foundations for the bigger potential in sustainability of the WRF, namely a setting which by the nature of its existence and location, holds the potential to be a true sustainability center. It was specifically this aspect of the WRF, the way those involved with the WRF straddle the divide, which prompted this research. This research is accordingly firstly looking at the current status quo, namely, is the facility a conduit towards relevant robust knowledge, useable by policy makers and those implementing such principles towards sustainability. Secondly,

the research looks at the possibility of the activities at the WRF playing a direct current and potential future role in the science of sustainability, which naturally encompasses climate change. Vogel et al. (2007) express the need for greater collaboration and better communication between stakeholders and suggest boundary organizations may play a role to address future issues surrounding sustainability and climate change. In essence then, from where the WRF is now, is it in a de facto sense playing such role?

3.3 Current Challenges

3.3.1 Sustainability

Sustainability is possible only if science and technology are mobilized to action at an increased pace and is thus considered (Cash et al., 2006).

In essence, sustainability challenges the people of the world to work together in finding solutions to a better managed planet where all humans and future generations can sustain their lives on the planet. Science is a tool, in that process, which has given rise to various assessments; such is those from the IPCC to gather data as to exactly what the situation is to be dealt with. It has found great dichotomies between the developed and developing worlds, where the developed world is older with resource surpluses and considering global issues, whereas the developing world is younger, but poor with shortages of resources, where the research is more action driven (Clark, 2005).

To manage sustainability interactions from developed and developing groups are necessary. The right knowledge to allow good decisions in relation to sustainability, demands multiple levels of interaction, which is affected by the "interplay between institutions at multiple levels and scales" (Cash et al., 2006). The authors point out that for societies to improve towards sustainability a transitional phase is necessary. Intimately linked to this task is the capacity and state of the planet. Clark (2007) suggests sustainability is best defined by the problems it addresses, rather than by the disciplines it mobilizes in order to achieve the result. At present then, in respect of sustainability it is a wide concept where academic understanding is given effect to, through communication, leading to the mobilization of implementation structures. Implementation structures, such

as governments through policy, see the process through, or fail. The thin dividing line in sustainability between failure and success is if this transition inspires the next role player in the relay race towards sustainability to participate. This is so because sustainability is not one or other isolated event, but a taking of hands by the participants of life, influencing the outcomes. It is an interrelatedness which will only effective when all its parts are attended to by those able to do so. In effect then, what Clark is saying is right, that at best sustainability must be tackled where the problems are, because that is in the sustainability chain where the weaknesses are, and presumably the same applies to sustainability as to the rest of life, that it is as strong as its weakest link. The suggestion herein then is that once the problem is identified, correct mobilization towards implementation must take place or the weakness remains and may become worse.

Sustainability centers as boundary organizations can play a meaningful role in resolving problems through research and mobilizing solutions, through interactions with the correct stakeholders for implementation (Miller, 2001). Research needs to be salient, relevant, legitimate and reliable (Cash et al., 2003). With implementation trust is essential (Dickson, 2008). Research also needs to be over sufficient lengths of time to transfer into technologies and solutions which, when implemented, can reduce impacts and promote sustainability over time (Mitchell et al., 2006). Monitoring of implementation is essential to ensure good outcomes for the future.

Sustainability and boundary organizations as a tool towards sustainability are dealt with extensively later in this chapter.

3.3.2 CLIMATE CHANGE

Climate change is investigated as it is the effects of global environmental change at local level. The anticipated changes in climate are likely to increasingly affect the area in which the WRF is located in. The facility is accordingly potentially important to assist South Africa in dealing with climate change.

The poor and vulnerable are expected to carry the brunt of climate change (Cash et al., 2006; McNie et al., 2008). Often the worst effects of climate change will be felt most in

remote areas, far away from traditional research facilities (McNie et al., 2008; Vogel et al., 2007). Despite these difficulties, research needs to be conducted and solutions found to reduce the impacts of climate change. For this a base is necessary, as continuity is of the utmost importance if good outcomes are to be achieved (McNie et al., 2008).

The WRF may be an important future tool in the mitigation and adaptation process of climate change in the region, as a center from where research can be conducted, and adaptation and mitigation strategies implemented.

Climate change is already affecting the area the WRF finds itself, in the form of droughts and changed germination cycles (Shackleton et al., 2008). Global environmental change is a response to a higher atmospheric temperature, whereas climate change is the response to such changes in a specific region, such as where the WRF is situated (Kasperson and Kasperson, 2001 and Kasperson, 2005). Climate change will accordingly from time to time affect the community surrounding the WRF. Because of the vulnerability of the society, already identified by the South African government as a poverty node, climate change risk may impact severely on the community and is therefore considered as a current challenge to the WRF in producing science which is relevant thereto.

The Intergovernmental Panel on Climate Change (IPCC, itself regarded as a

Boundary Organization), predicted in their 2007 report, that widespread consequences of climate change must be expected. Such changes are envisaged to take effect much earlier than previously estimated. The effects of climate change may impact billions of people. Effects from climate change are numerous and unpredictable. Examples are: water distress, displacement, food shortages, increased health impacts, loss of livelihoods, loss of ecosystems, loss of fauna and flora, and the creation of additional stress to already weak governance and implementation structures and resultant poverty.

The complexities of climate change demand that science be the foremost tool to combat the situation per region. Sustainability managers will need quality scientific research which can investigate climate change and find scientific and other solutions at various levels. Once the effects of climate change are identified, mitigation strategies may be planned and implemented. Societies can in this fashion be assisted to adapt and be more resilient. This necessitates a multi-level structure in need of management from a specific

base. In 1988 the United Nations Environmental Programme (UNEP) and the World Meteorological Organization (WMO) established the Intergovernmental Panel on Climate Change (IPCC). The reason was to understand human induced climate change and its impacts on the environment and socio-economic structures of society. Solutions for adaptation and mitigation were sought simultaneously. In its 2007 report the IPCC predicts that temperature will probably rise by a further 1.1 to 6.4 Degrees Celsius, or to 11.5 Fahrenheit during the twenty first century. Many factors contribute to climate change, for instance the dynamics of the planet, the intensity of the sun, and then, since the industrial revolution, the people of the earth. To measure change, a number of indicators are researched.

Glaciers are of the most important indicators of climate change (Seiz, 2007). There is significant worldwide shrinking of glaciers (Zemp et al., 2008). The interaction between the oceans and the atmosphere can also influence weather patterns such as the El Nino Southern oscillation influencing southern Africa, the region under discussion (Moser and Dilling, 2006; Baxter et al., 2008). The IPCC Working Group 1 reported that carbon dioxide levels is the largest current threat for increased climate change, and is regarded to increase the temperature contained in the atmosphere as it reduces the re-radiation of heat from the sun. The earth's atmosphere needs to capture and re-cycle energy captured by the earth's surface to create stable climate. A heightened temperature destabilizes this pattern and has the potential to exacerbate changes to climate in the short and long term (IPCC 2001 Special report on Emissions Scenarios).

Climate change is also affected by solar variation and other orbital variations, plate tectonics and volcanism (WWF 2006 Living Planet report). NASA released a study in 2003 which shows that cyclical sun spot activity affects Global warming. Certain human activities, such as burning fossil fuels, cement manufacture and land uses such as irrigation, deforestation and agriculture, may change the environment (IPCC report, 2007).

Vegetation is affected by climate change as increased CO2, moisture and warmth can speed up the growth of plants. However, sudden and extreme changes in temperature are likely to cause vegetation stress and rapid plant loss and desertification (Bachelet et al.,

2001). Increasing temperature and resultant melting of the ice-caps will cause sea levels to rise with increased precipitation. This will lead to expansion of the subtropical desert regions, yet increased desertification in already dry areas. The IPCC 2007 report in its technical summary blames CO2 emissions for two thirds of the man made problems and changes in land use. Deforestation is said to be responsible for the other third of the problem. The same paper comments how the terrestrial albedo is changed by use, leading to radio-active forcing. Such effect is mainly local, rather than global.

The Third Assessment Report of the IPCC on Africa reports lowered yields of grain, changes in run-off and water availability and increased floods and droughts, significant plant and animal species extinctions, increased diseases such as malaria and cholera and changes in grassland and marine ecosystems. Africa is accordingly already greatly affected by climate change and the situation is likely to worsen as the effects of climate change sets in over decades to come (Washington et al., 2004). It is doubted that sufficient steps are being taken to be able to adapt to climate change. Southern African desertification will increase. Food security may be greatly impacted (Lebel et al., 2007). Kirkland et al. (2007) report that livelihoods in the immediate surroundings of the WRF, are impacted.

The impact in Africa is exacerbated by weak economies and low level governance (Moser and Luganda, 2006). African countries lack infrastructure. Further, governments in Africa tend not to deal with the crisis of change. This results in a dim outlook for the continent (Mock, 2005). The African continent shows great vulnerability (Shackleton et al., 2008). Already a quarter of the African continent is under stress of insufficient water availability and is semi-arid. Food scarcity and disease are further problems. The IPCC suggest adaptation and mitigation to assist the African continent and its people with expected changes. The poor are likely to suffer most (Kirkland et al., 2007; McNie et al., 2008). The IPCC calls for a more “nuanced” approach. A more inclusive approach would need the forging of partnerships between government, social structures and economies towards sustainability implementation (Vogel et al., 2007). On a regional basis the question arises, ‘who will drive these adaptive strategies, especially in cases where government is not facing up to the challenges?” This research suggests that the WRF is such driver and can be a valuable instrument in dealing with the ills of climate change.

3.4 Assessment

3.4.1History:

To assess the WRF as a sustainability center the history and past conduct of the WRF was briefly considered. The assessment needed to show the WRF produces research which is salient, relevant and legitimate in the context of its location. Knowledge produced, need to transfer to appropriate policies and implementation models (Mitchell et al., 2006). A historical overview was necessary to consider this against the information provided by those interviewed in the study.

The country, in which the WRF finds itself, South Africa, is located in the Southern most tip of Africa with the Indian Ocean to the East and the Atlantic Ocean to the west. The coastline stretches 2798 kilometers (1739 miles). Modern humans inhabited the area for at least 100 000 years. The Portuguese seafarer, Bartholomew Dias brought the area to the attention of the Europeans in the 15th century. In 1652 the Dutch created a trading post for the sea route to India, sending mainly a group of French Huguenots, then recently exiled from France, to man the post. For about a hundred years, less than 20 new immigrants arrived, but the settlers were later complimented with new arrivals from Holland, Germany and Belgium. The British colonized the area in 1806. During the 1800's Britain sent groups of settlers who mainly settled along the eastern seaboard, forming the Cape and Natal colonies. Later in the 1800's settlers from India arrived to assist with sugar cane farming. By the 1830's the original immigrants had became disgruntled with British rule and taxes. A large number of these settlers had moved inland, creating inland republics. The republics were united with the British colonies into one country after they lost the Anglo Boer war to England in 1902. In 1910 the Union of South Africa was formed, a country with limited independence from the United Kingdom. In 1948 the National Party came to power which implemented a strategy of segregation of races to deal with the different ethnic groups in the country. At the heart of this system, apartheid, was the intention of one group to weaken the rest, so it can unhindered use the resources of the country for a select few. The surrounding area of the

WRF was impacted through apartheid by suffering an increased population on marginal land.

Narsiah and Maharaj (1999) report how the area of Buschbuckridge (BBR), where the WRF is situated, remains a victim of the past between apartheid, identity and geography. Makhura (2006) reflects on the diversity of the country and the area. His narrative of the different tribes which inhabited the area, is as follows: "The region was populated by multiple and ethnically diverse, but interrelated communities. It was inhabited by the San (Hunter-Gatherer, Basarwa or Bathwa) groupings prior to the settlement of various Late Iron Age farming communities, the ancestors of modern Sotho-Tswana and Nguni societies. The north-western and southern portions of the region came to be broadly occupied by the Kgatla (Bakgatla), Rolong (Barolong), Ntwane (Bantwane), Koni (Bakone), Kopa (Bakopa) and Southern Ndebele mixed farming communities. The north-eastern parts were largely settled by groupings of the Eastern Sotho and the Ngomae, as well as the offshoots of the Swazi and the Shangane…..In Mapulaneng

(Bushbuckridge) was the descendants of the Pulana Chief, Seganyane Mahile who moved into the area during the reign of the Maripe."

The apartheid regime in the 1980's "re-located" people to areas of it's choosing in an attempt to create an ethnic nationalism (Narsiah and Maharaj, 1999). These areas were called Bantustans. After such moving of people into the BBR area, a land dispute arose between the Lebowa and Gasankulu Bantustans over land in BBR. The Lebowa Bantustan claimed land in BBR from the Gazankulu Bantustan. Lebowa was also in a land dispute with the then province of the Transvaal, complicating the issues at different levels. Apartheid ended in 1994 but the complex often politicized issues over land in BBR, continued as legal struggles at local, regional and national levels, and many issues remain unresolved (Narsiah et al., 1999). According to the South African Business Trust report, based on the STATS SA 2001 report, in respect of Poverty nodes, the average unemployment in the BBR area is 86% and for the country of South Africa it is 77%. It means only 14% of people in the area in which the WRF finds itself are employed. Average income per person for a year is R5414 or about US $500.

Poverty is accordingly rife. Thornton (2002) predicts that with no intervention, conflict in the region will increase in years to come. Thornton cites the high unemployment, low growth, with a mindset of winner takes all in the society, as the greatest potential reasons for conflict. The state of mind of entitlement of a few controlling the rest, will, according to Thornton, require changing to a new mindset of a desire for economic growth instead. Thornton foresees a clear need for mediation to resolve conflict and also to unite the parties towards a common goal of prosperity.

The BBR region's subsistence farming created serious erosion gullies in the local wetland. Erosion is a constant threat over a wide area where the poor strive to eek out a living (Oliver, 2004). Prosperity would however, require economic growth and development and this can greatly affect the already fragile ecosystem. BBR is situated in the Waterberg Biosphere, the first region in the northern part of South Africa to be named a Biosphere reserve by UNESCO. The ecosystem can be characterized as a dry deciduous forest or Bushveld. The area spans 2,400 square kilometers. The population is estimated at between 700 000 and 1 million (Du Toit et al., 1999). Du Toit et al. (1999) describe the conditions as "unsustainable land husbandry and natural resource management". They characterize the area as "open woodland which is under heavy pressure in the peri-urban areas in the west and near settlements in the eastern areas. As the community depends on the wood, natural resources are under great threat." Du Toit et al. further list the problems on the natural resources as "population pressure, unclear tenure systems, weak local government structures, conflict agendas of the different service providers, and the lack of clarity on the mandate of traditional authorities, as well as low levels of awareness and knowledge on environmental issues, and lack of sufficient financial resources. "

Social, cultural and political engagement shape the agricultural production in Africa, and it is suggested that for agriculture to succeed the building of these relationships need to be taken seriously (Scoones et al., 2005). Vogel (2006) points out that climate change is mostly unfavorable for African agriculture, causing great vulnerability amongst the poor. Drinkwater (2005) highlights the far reaching effects of HIV/AIDS on livelihoods in Southern Africa. He warns that the full impact is not understood yet and the disease is continuing to take its toll and grow. Twine and Hunter (2008) show increasing reliance on natural resources as the effects of HIV/AIDS impact on poverty struck communities.

The region under discussion is therefore plagued by the hardships of poverty and disease, a community in distress.

The WRF is very low key in the description of itself on its official website. Other than mentioning its locality and that it is a base for "rural-focused research, student training and community outreach in the Bushbuckridge region of the Northern Province, South Africa", it has descriptions of its facilities in the vein one would expect from hotels or conference centers. The website does, however, give the web addresses of "resident programmes involved in research, education and outreach", and then list programmes such as Agincourt, Award, Radar and SUNRAE. The WRF will need to play an increasingly important role in monitoring climate change as there is a lack of seasonal prediction information in Africa and catalysts for research and communication will be essential (Vogel et al., 2007).

The Wits Rural Facility lies between the Timbavati game reserve and the Kruger National Park, some 500km from the Wits main campus, is a modern facility, specifically designed to focus research on poorly resourced rural communities. It attracts scientists from all over the world. A number of the University of the Witwatersrand departments, other South African universities and foreign universities, such as Yale and Oxford, use the facility for academic purposes.

The WRF was chosen for this research as from personal first hand experience in the hardships of implementation; it stood out as a solid center practically bringing through its presence sustainability to the area. Having dealt with implementation in various forms over years the WRF impressed as a place where the tangible difference its presence made was obvious in actual projects, schools, and even community commerce.

Communities are made up of government in one form or another, commercial activity (and very often amongst the South African poor the lack of it), and society itself, with educational and other structures as part of it. Where there is coherence and common goals with these structures, communities succeed. Where selfish agendas are followed, goals of implementation remained unsatisfied (Kalala, 2002). Personal experience with implementation showed that often the actual physical difference made in a society, came when individuals, enthusiasts linked to an organization nearby, acted on needs in the

community. Such individuals would walk the extra mile with a dogged determination to bring better outcomes to a community. Such enthusiasts did not rest till the projects to bring an improvement were started or until solutions to the problems were found. Here at the WRF though, was something unique, instead of just the odd enthusiast there was a group of like-minded people committed to a community and simultaneously to a university, who forced great relationships of trust into the actual community and their results were tangible. It was evident it is a special place worth looking at to consider the reasons for its success.

At first glance it appeared the presence of the WRF had a synergistic effect in respect of the community. The medical and school facilities enable enthusiasts from the WRF to meet leaders in the community. Students get exposed to government and non-governmental organizations through common interests, from where certain projects were developed. Such enthusiasts seem to have created a network of close links into the community starting off through research but developing into friendships and by the time return visits took place synergies beyond the call of duty had developed. It appeared the energy shared forged solutions for the practical problems their scientific research uncovered, thus the presence in the community led to better outcomes. McNie et al. (2008) describe similar encounters where people who spend a long time on the boundary become pillars of the process of sustainability. From personal observation this was the case with the WRF and created a curiosity to conduct this research.

3.4.2 The current milieu:

It was investigated if the WRF, against the backdrop of climate change and Southern Africa suffering a vulnerability crisis, is a sustainability enhancing boundary organization. The present is shaped by the past and accordingly previous approaches of dealing with sustainability issues were considered.

Disciplinary approaches in dealing with climate change are slow to transform and adapt to current needs (Vogel et al., 2007). Vogel et al. describe the web of knowledge created in the quest to find meaning in the relationship of science and policy in dealing constructively with the changes at hand, as a “spider’s web”. This is a reflection of the

complexity of the issues at hand, but also shows the grappling for answers at a time outcomes are uncertain. A "spider's web" is perhaps a good start for building a multi-dimensional structure which, on an increasing basis; is adept to absorb and annul the challenges of climate change. It is however important to look at past development to understand how to pave the way into the future. Ideally ways must be found which are concrete and planned, rather than links stumbled on in unraveling ways to deal with the crisis the world faces on so many different fronts. Considering the efforts all over the globe there should be a confidence that this taming of the problems will bring stable tested ways. At present though, sustainability is in many respects a new and uncertain frontier. Cash et al. (2006) comment on the multi-faceted interactions and solutions institutions can incubate. As such, an institution such as the WRF, can play a meaningful role in being part of a multi-level grid facing the enemies of sustainability; namely poverty, lack of safe drinking water, lack of sanitation, lack of education, lack of housing, poor health, to name but a few.

The initial direction for dealing with sustainability was set by the Brutland Commission's definition of sustainable development, namely "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Even then, this definition was born from the complex grappling by governments and academics to give simple and practical vocal effect to the complex idea of sustainability.

The interplay between science and policy gave rise to increased multidisciplinary research (Vogel et al, 2007). It became necessary because it took time between research institutions producing findings, till governments and industry could respond. This caused Notwotny et al. (2001) to suggest the creation of knowledge which reaches out to society directly in order to bridge the lopsidedness of knowledge on one hand and delayed reactions where it is needed. Academia has for so long had a stronghold over knowledge that they appear to have difficulty giving up such stronghold for a more inclusive or multidisciplinary approaches (Jasanoff, 2003).

John Robinson (2005), of the University of British Columbia in Vancouver, warned at the 6th Open Meeting of the Human Dimensions of Global Environmental Change Research Community meeting in October 2005, that there is resistance from those set in traditional

ways, to interdisciplinary research. Robinson comments how interdisciplinary methods are often viewed as "the ghetto of the incompetent" by traditional disciplines. He further pointed out that it is certainly a challenge to institutionalize inter-disciplinarily research. Societal demands have modified the research necessary by universities into more applied

Research (Cash and Moser, 2000). It is established that research towards more streamlined technology transfer for commercialized knowledge production is necessary (Steinberg, 2005). An alternative model of university research would revert to curiosity driven research and can involve engaged research, having not merely commercial outcomes in mind, but taking societal demands in account and as such still producing outputs for society (Nowotny, 2003). Researching the WRF was useful to give effect to the idea of Robinson's that we are a global society in transition and all actors need to fulfill their role and participate.

Pepper, (2003) summarizes the evolutionary processes which affected the rigid disciplinarian approaches of the past towards the wider sustainability approach. Pepper pointed out that "if we are to solve our environmental problems, we have to find ways to resolve the tensions between these opposites, namely:

- individual freedom versus common good;
- the protection of national sovereignty versus the need for global awareness;
- the rights of minorities versus majority rights;
- the protection of the right of the present generation versus those of future generations, and
- values associated with the desire for affluence and individual material possessions and those connected with social and environmental justice and the non-material, spiritual, sides of our nature."

Attitude and behavior is therefore not always synchronized as they relate to environment in the wider sense. A desire for solutions is necessary for sustainability to work in the future. As Pepper (2003) points out, this places a question-mark over the legitimacy of the pursuit of private interests for the profit of individuals (or corporations) from

exploiting resources, whilst the environmental degradation, which may result, is borne by all. Society needs to rally together. Groups can form alliances or partnerships to give effect to a combined approach of overcoming the problems we face in the twenty first century (Pielke et al, 1997). Already Universities such as Cornell, Penn State and Kansas University have sustainability centers at their campuses. The specific value of the WRF is that it is in a rural area away from its metropolitan campus, with the ability to span boundaries into an developing society on a long term basis. Inevitably it creates links to mediate between science and politics.

The history bears out this aspect. Traditional boundary organizations were developed in the United States as mediators between scientific and political institutions (Miller, 2001). Over time, boundary organizations became a useful tool to analyze the role of scientific organizations in relation to the societies in which they operated (Johannson, 2001). Miller (2001, 480) warned that the original theory of boundary organizations is "too static" to keep pace with the needs brought about by the rate of globalization we are experiencing at present. Miller (2001, 495) therefore calls for "nuanced arrangements" to overcome the problem. Guston (2001) further examines boundary organizations operating between knowledge and "applicability".

Early implementation of academic research, turned into useable technology and solutions, is suggested as a dual activity between an institutional boundary organization and the community intended to benefit from such research, knowledge and technologies. The reaction of the community, particularly when feedback is given early to the institutional boundary organization, can be useful towards meaningful implementation. Direct and immediate observation of the results of technology and knowledge transfer will enable the academic institutions involved to become more effective.

Regardless of whether the reaction from the community is negative or positive, such feedback can influence the thinking patterns of those producing the knowledge or technology, thereby ensuring that it is more sensitive to the need of the community. Therefore, a border, or 'boundary' organization can be of use to an academic institution if there are problems between the interaction of science, knowledge and the practice. Early

implementation of research and more goal-orientated research through activities fostered by a boundary organization is likely with a more consultative approach.

Johansson (2001) points out that an organization practicing on the boundary must clarify its functions and purposes. Even more important is, "how well the organization manages to co-ordinate different interests within its field" (Johansson, 2001). Cash (2001) emphasized the tensions, vulnerability, stressors, and a "recasting" of interaction between academics and implementers. He identified organizations which play an intermediary role as of the greatest significance, but pointed out salience, credibility and legitimacy is of the essence. He pointed out the challenge is to harness the "boundary", spanning potential of multiple individuals and organizations in ways that can most effectively bolster, salience, credibility, legitimacy, and the tradeoffs, among them. Such research and outcomes are necessary to establish the truth in respect of the climate.

It is good that the debate has been so intense and ongoing, because over the last century science increasingly revealed changes in climate not responded to timeously, whereas pro-active responses may save lives and money (Washington et al., 2004). Because policies are formulated too slowly and not responded too sufficiently, such as is evident from the Kyoto Protocol, mitigation and adaptation is limited in success.

Climate change is now regarded as the most serious threat facing human kind. In 1994 Al Gore, the then US Vice President said: "Climate change is the world's most important environmental threat." Yet, only with increased changes of climate and his joint win of the Nobel Prize in 2007, did awareness of the problem become main stream for the general public.

Al Gore shared the Nobel Prize with the IPCC team reporting for the fourth time. The IPCC and the United Nations have shared science and policy responses, as set out below. Climate change prompted the leaders of the United Nations to adopt the UNFCCC (United Nations Framework Convention on Climate Change) which came into force on 21 March 1994. From this followed the Kyoto protocol. These agreements have environmental and economic relevance.

The environmental aims can only be achieved by fundamentally changing the basis of production, consumption, transport, investment and energy provisions of the world.

Unlike other framework conventions, the UNFCCC is less inclined to strict schedules and rather create outcomes and structures to address climate change. It does so through provisions such as the Kyoto Protocol. In Article 2 the UNFCCC calls for greenhouse gas concentration that would prevent dangerous anthropogenic interference with the climate system. Five principles guide, namely, recognition of needs of developing countries, intergenerational responsibilities, precautionary principles, sustainable development and global co-operation and an open international economic system.

Annex 1, or developed countries, were to also adopt policies to mitigate climate change and review their policies and practices, assist developing countries that are vulnerable to the effects of climate change, by helping with the cost of adaptation, and promote transfer of technologies.

The UNFCCC created five bodies, the Conference of the parties (COP), meeting every year and the Decision Making Body, the Secretariat, the Subsidiary Body for Scientific and Technical Advice (SBSTA) and the Subsidiary body for Implementation (SBI). The SBSTA gives advice to the COP on science, methods and technologies. The SBI assesses and reviews on implementation. The bodies overlap on compliance and capacity building. The financial body created is the GEF or Global Environmental Facility. The COP determines criteria for funding. The other important body in climate change negotiations is the IPCC, the International Panel on Climate Change. It was established by the World Meteorological Organization (WMO) and the United Nations Environmental Programme (UNEP) in 1988. The IPCC prepares assessment reports and technical papers and special reports at the request of the SBSTA. The SBSTA is accordingly the link between the COP and the IPCC.

Annex 1 and 2 countries, as defined in the Kyoto Protocol, formed groups for negotiations such as the European Union group, Countries with Economies in Transit or EIT's, the JUSSCANNZ group with amongst others the United States and Japan, Africa, Latin America and other groups.

Africa is one of the most vulnerable continents in respect of climate change (Vogel, et al., 2007). As different stressors impact societies, populations have little capacity to adapt.

Bolo (2004) discusses the complexities which Africa face as endemic poverty, complex governance and institutional dimensions; limited access to capital and markets, infrastructure and technology, ecosystem degradation and complex disasters and conflicts. For these reasons the IPCC termed Africa weak in adaptive capacity and making the need to be proactive on the continent to deal with climate change more urgent. What is of great concern is that the IPCC reports that adaptations may be insufficient in a vital area such as agriculture. It also reports that water stress will become chronic and in some instances extreme. As the climate changes, humans are likely to over populate wetter areas and harm already fragile eco-systems and wetlands. Human health is likely to be further impacted adversely. Ecologies are likely to change and have a further spread of diseases such as malaria as a result. The IPCC calls for further research in the areas of dengue fever, meningitis and cholera, all diseases likely to increase as the climate changes.

As to Southern Africa, for instance Angola, Namibia, Mozambique, Malawi and Zambia, heavy rains increased as well as changes in seasonality took place. Christensen et al. (2007), and Washington et al. (2006), discuss the El Nino-Southern Oscillation

(ENSO) influencing the changes in climate. The drying of the Sahel since the 1970's is linked with equatorial Indian Ocean Sea-Surface Temperatures (SST), whereas ENSO influences rainfall at inter – annual scales (Christensen et al., 2007). Droughts have through the ages led to human migration, separation and population dislocation. Few et al. (2004) reports how health problems like diarrhea, cholera and malaria often follow impacts from droughts and floods.

Land use changes impact on people's ability to grow subsistence crops (Shackleton et al. 2008). Agriculture is critical for African livelihoods and Gross Domestic Product (Mendelson et al., 2000). ENSO adversely impacts on large groups of the African population. Factors such as fire, invasive species and land use changes impacts. Water quality is often poor, causing diarrhea, intestinal worms and trachoma. In this fashion the poor often suffer greatly from a lack of safe drinking water and poor sanitation.

Economic development in Africa varies greatly from area to area. Some legal and institutional frameworks in Africa are reported by Sokona and Denton to be inadequate to

deal with climate change. Some sectors of Southern Africa have however over the last decades improved water access and management (Van Jaarsveld et al., 2005). The UNDP report of 2005 projected that 24 African countries will not meet the Millennium Development Goals (MDG's) and no African country with significant populations are likely to meet the child and maternal health standard. Further, a total of those living off less that $1 per day is likely to increase from 24% to 41% by 2015.

Water – impact will increase for the South and North of Africa and East and West Africa may have less water stress. Hydrological influences may affect the predicted outcomes. The IPCC reports how dramatic the influence of water stress will be on the African population with even only 1 degree Celsius increase in temperature. The commission urges that Mitigation and Adaptation strategies must urgently be sought per region.

Human Health -Background stressors such as HIV/AIDS, conflicts and wars, may be impacted further by climate change. Harrus and Baneth (2005) warn of the increased potential of cholera and malnutrition.

Animal Health - Africa as home of many species, and Southern Africa in particular with of the greatest biodiversities in the world, may be seriously affected by heat stress and drought as will terrestrial and aquatic systems be vulnerable (Nkomo and Gomez, 2006).

Brooks et al. (2005), reports that outcomes of adaptation are linked to sustainability, good governance, literacy and effective civil and political rights, This was the case regardless of technologies involved, skills, education, information provided, infrastructure available and access to resources. The integrity and management of the situation is accordingly of utmost importance. Programmes such as water harvesting after rains can reduce drought stress (Rockstrom, 2003). Adaptation practices such as diversification of livelihoods, income generating projects, non-farming incomes give relief (Bryceson, 2005).

Reid and Vogel (2006) pointed out that there was a need that the role of Institutions, whether formal or informal, should be better understood. Institutions as boundary organizations are considered below in greater detail.

3. 4.3 Boundary Organizations:

The framework and relevance of boundary organizations were considered. Forsyth (2003) defined boundary organizations as "Social organizations or collectives that sit in two different worlds such as science and policy, and can be accessed equally by members of each world without losing identity." Jasanoff (1990) suggested boundary work is "the strategic demarcation between political and scientific tasks in the advisory relationship between scientists and regulatory agencies". As such then boundary work, or organizations could operate from anywhere, because these are functions taking place in all societies. Guston (2001) pointed out that this is a safe place in which to operate from both sides.

Cash et al. (2003) looked at practical examples of existing boundary organizations such as those managing Aquifer Depletion, El Nino Forecasts, Managing Ocean fisheries and the like. The authors observed that effective boundary organizations communicate effectively, link knowledge to action and mediate towards solutions. These are important guidelines and are of the key aspects considered in the current research, namely the effectiveness of communication of the WRF, its ability to link knowledge and action and its ability to mediate towards solutions. In relation to boundary organizations it must however be understood that at all times the WRF is a boundary organization in the sense of its being an official arm of a university in a rural area, and all that is said about boundary organizations applies to it formally already. The issue which is added here is specifically in relation to sustainability, in that added dimension, where the link to action is essential, what is the extent to which the WRF is successful? That is where the importance comes from the WRF not merely being on the boundary between science and politics, but physically on the border between the developed and developing worlds and if this dual boundary is benefited through its presence.

Guston (1999) pointed out that boundary work, which is a process and boundary organizations (the structure) must not be confused. Accordingly when considering the WRF it is important to keep in mind that there is an overlap where boundary work is housed in a structure (as opposed to some of the boundary organizations mentioned above) as the process may be enhanced by the presence of the structure in the

community, yet have qualities of its own. Guston (1999) provided characteristics of boundary organizations which they regard of importance after having examined as case studies five such organizations. The authors suggest working characteristics to be those based on trust and truth, where the needs of the user are recognized, where the research agenda can adapt to the needs, and is made accountable. As to the issues of credibility, relevance and legitimacy, it was considered these aspects required better definition, but were the cornerstones for any boundary organization.

The tone set by Guston (1999) was followed up by Cash et al. (2002) and Cash (2003) and Cash et al. (2003), resulting in the following adaptations to use as questions in the research :

- Is the WRF relevant in it's interactions with the community?
- Is the WRF practically enhancing sustainability, i.e. positively impacting health, livelihoods, and ecosystems?
- Is the WRF there for the longer term, i.e. can the community rely on it's presence and interactions over time? +

Lobell et al. (2008) express the opinion that adaptation methods to climate change need to be sought urgently to prevent scarcities, such as food, which is central to sustainability. Vogel et al. (2007) use figure 1 at page 6 of their study to express insights of Mitchell et al. (2006) based on Clark (2002) in showing in practical terms the inter-relationship between science and practice. Although practice is not defined by Vogel et al. (2007), other than it being used as a broad term to describe other role players in the process, it is intended to display the interwoven nature of sustainability. This research then examines if the WRF has had the ability to create interconnections of such substance that it has woven sustainability principles into the fabric of the community it finds itself in (see figures 2 – 4 in Chapter 3 hereof). Vogel et al. (2007) do not promote boundary organizations specifically as a tool towards sustainability, and call for further research, however, they recognize a dimension for communication and interplay between science and practice is necessary.

Sustainability and boundary organizations have formed the basis of debate over time. In "The Common Journey: A Transition towards Sustainability" a call is made for a structured approach towards sustainability. It warns at page 277 that societies could be left vulnerable to even foreseeable threats if academic knowledge is not mobilized into purposeful and measurable solutions. Vogel et al. (2007) confirm this and call for expansion of a multi-dimensional grid of interactions and communication. In "The Common Journey" a call is also made for a "long term intelligent investment in the production of relevant knowledge, know-how, and the capacity to use them both must therefore be a component of any strategy for the transition to sustainability". Considering the results of this study, the WRF answers such call for action, as it already have both elements of knowledge and putting it into action towards sustainability and dealing with climate change, as appears from the results below.

The Common Journey also called for broadly based research recognizing that knowledge in one sphere may lead to solutions in another. It highlighted the problem of too little observational data and the underdevelopment of an "appropriate" professional community to provide comments and reviews on such wider based research. This study did not set out to consider this specifically, but it should be an important part of the debate that the WRF by it's mere existence and link into the academic institution is raising people academically who have those sought after abilities to play a meaningful role in achieving meaningful research results and monitoring implementation in the wider sense. In "The Common Journey" a direct call is made for Africa (at page 13), that amongst other suggestions, the scientific community must mobilize towards "actions to achieve the technical capacity and implementation needed".

A number of authors also looked at the question: "What are the characteristics of a boundary organization?" The characteristics pointed out by Cash et al. (2003), namely:

- Salient - relevancy of interaction is essential
- Legitimate - the organization must not only be seen to act legitimately, but must have the de facto support of the boundary community as an actor which comes with goodwill and legitimate intent

- Credible -a boundary organization cannot be frivolous. It must be an organization which is reliable, particularly if it is to play a role as a conduit towards sustainability, were considered in respect of the WRF.

When does a boundary organization become a sustainability center? A sustainability centre, in the form of an 'institutional boundary' organization, will need to facilitate communication between actors from the institution and from the community (Tribbia and Moser, 2007). Such parties may have different goals initially. It is visualized that communication between them will lead to more coordinated boundary management outcomes (Pielke et al., 1997). The interplay and tensions, practical applications, commercial influences, governmental and de jure and de facto governance in a community, and in an institution, is expected to shape each other towards greater relevance in the case of the boundary organization and towards sustainability in the case of the developing world (Jasanoff, 2008). It is anticipated such communication will lead to more effective science, knowledge and technology transfer from the academic institution to the developing world (Vogel, 2007).

The rationale of the present study was to expand on the characteristics identified by Cash et al. (2003) and Cash et al. (2006) and developed further by Vogel et al. (2007), Moser (2008) and Jasanoff (2008). This study shows that if a boundary organization put out the 'frame', namely: relevancy, legitimacy and credibility, that through human effort fruit towards sustainability is borne in the form of concrete projects, partnerships and a real difference to the community involved. The study highlights the foundations in an institutional boundary organization which are necessary to enable an investigation of some of the needs and influences in the society it serves.

Complementing the idea, Cross and Spencer (2009) highlight the requirement that human needs and the practical situation at hand should dictate solutions which lead to true improvement of people's lives, making societies more sustainable.

Knowledge sharing between researchers and decision makers and interaction between scientists and decision-makers is therefore an important positive outcome of a successful institutional boundary organization (Ayensu et al., 1999; and Clark et al., 2005). The WRF was measured and found to have a high level of impact in such regard.

Sustainability needs to use knowledge gained from research to make choices that bring solutions (Hannigan, 2006). Innovation is likely to play a major role in protecting the natural environment and enhancing human health. The BOSC review (2006) saw this decision support as imperative. The second fundamental recognized, is stakeholder involvement. The Environmental Protection Agency (EPA) research strategy (2007), calls for enhanced research, new tools and methods and finding synergies to close knowledge gaps towards desired sustainability outcomes. Vogel (2005) calls for prioritizing and combining the development and climate change agenda, which will no doubt have a positive impact on sustainability.

In "Global Environmental Assessments" Mitchell et al. (2006), pointed out that environmental knowledge escalated rapidly in the last decade, but there was no corresponding outflow of policies and implementation towards sustainability. Vogel et al. (2007) warned that unless communication is clear and effective to stakeholders, such stagnation will occur and implementation will be slowed down. The current literature points out that salience and credibility and legitimacy is imperative, the same principles examined in this research. Mitchell et al. (2006) warned that what is perceived as knowledge is often tainted by bias, innocently or purposefully coming into the mix to satisfy outside audiences. The integrity of research is accordingly of the utmost importance.

From a synopsis of a study by the Social Learning Group at the Kennedy School of Government at Harvard University, "Learning to Manage Global Environmental Risk" a number of key factors to manage greater environmental issues, and thus sustainability, are mentioned, namely:

• problem identification and goal definition;

• the formulation and implementation of action programs and policy;

• the impact of ideas, interests and institutions;

• the extent of multiple actors in national and super-national arenas;

• the interrelationship between the efficacies of management of diverse areas of environmental concern.

• Investigating the role of learning in shaping society's direction to such management.

The intention of the study is to track the history and bring it into a usable focus for the present. Through this, it is hoped, a foundation will be formed for environmental management to build out pillars towards sustainability. Would the WRF be formally declared a sustainability center this study will be a useful guideline along which to formally enhance the WRF's capacity towards sustainability management.

In "The Bridge at the End of the World: Capitalism, Environment, and crossing from crisis to Sustainability", Speth (2008) points out the dangers of flawed policies and too narrow a thinking as to who must be involved. He calls for a change in personal and collective values to address global sustainability. The present study shows that institutions such as the University of the Witwatersrand through the WRF can create a practical physical place for those so inclined to participate in the process of sustainability. At present it does so as a secondary function, but if provided with the go-ahead and funding could be a pioneer in bringing reality to the calls of Mitchell et al. and Speth to produce socially robust information useful in creating sustainable societies. The WRF has the potential of going a step further, namely to be a node present in the community from which sustainability is managed with links into the society. McNie et al. (2008) comment on even boundary organizations without a base establishing relations by sending people into a community for six months and how relationships of trust strengthen boundary work. By the WRF being part of the community for over two decades, this is an important strength.

Notwotay et al. (2001) enhanced the idea of socially robust knowledge which goes beyond the formal research, leading eventually to governments and commercial entities, and instead having early communication links so that in a united fashion it may seek answers and solutions to problems encountered in the field. Karl et al. (2007) point out that the creating of new pathways need to enhance common ground and avoid the unnecessary. The goal orientated approach accordingly is most important if good outcomes want to be reached.

French and Gelderman (2005) highlight the importance of governance and political influence in not only areas of research, but also at models which will be chosen for

implementation. Scientific knowledge can accordingly become a strategic political tool (Jasanoff, 2007). Vogel et al. (2007) point out how 'silos of knowledge' still exist without becoming part of the solution, and that such knowledge if disseminated could become part of a knowledge bank towards solutions. Practically speaking, a body is necessary to address these issues and manage the process till a workable solution is found internationally in the management of sustainability. Again, sustainability centers can be nodes in such process, linking into one another as was visualized by Clark (2005).

In "Both sides of the border", Fernandez and Carson (Eds), (2008) point out the crippling cycle of widespread poverty, and how the border between the developed and developing worlds and science and policy is a place of great dynamism where experimentation and grass-root problem solving can take place. They urge that a trans-boundary organization need to take a holistic approach which recognizes the importance of social, cultural, economic and environmental forces in respect of problems and solutions in the area it serves. They point out that often in areas of great poverty; natural resources are the economy sustaining components of sustainable development. This was confirmed by Twine and Hunter, (2008). Accordingly research from a boundary organization needs to identify the forces that impact on these resources in the region. The abovementioned authors argue that a main advantage of being on the border in a sustained facility is the ability to understand the root causes of a problem, rather than identify mere symptoms of a problem as more superficial research is achieve. Further, border communities are often the line of first defense and absorb complex economic, environmental and social impacts. Salient research can provide answers that will dictate success instead of failure of solutions. A boundary organization gives the ability to identify a situation, find a solution and meet similar challenges thousands of miles away. The authors urge that more trans-boundary institutions are necessary, but must serve a wider purpose than merely the official views. They point out that trans-boundary organizations often play a modest part in a bigger scheme, but their importance goes beyond the formal impact, as they have the ability to channel and co-ordinate: they are to be beacons which shed light on the visible tip of the iceberg.

Vogel (2005) points out much can be done, despite the glooms of climate change. She calls on the need to understand that that which causes vulnerabilities, and then enables

those affected, that their resilience may be enhanced through building out institutional architecture towards solutions hand in hand with communities they may serve.

The ideal architecture is one that works in a particular situation depending on the needs of a society. In "Both sides of the border", the call is for a holistic inclusive approach. Institutions are urged to promote openness, transparency and trust. They point out how the risks on the border create tensions, and that how one deals with the situation can either lead to conflict or solutions. Again, the importance of a sustainability manager to show leadership at times of conflict and give direction towards positive outcomes is essential.

The design of a boundary organization as a sustainability center will therefore largely depend on the specific community it serves. Sustainability implies the maintaining of a certain status quo, whereas the boundary organizations envisaged are to rather serve as a place where a society will enhance its foothold in the climb towards sustainability (Guston, 2001). The earlier discussion pointed out that not all societies have reached sustainability yet, and that climate change will affect outcomes. This specific study therefore, focuses specifically on the human element in sustainability and therefore the fact that the WRF is situated in an impoverished area is important. That does not take away from the WRF also being an academic organization where disciplines such as environmental science, medicine, etc, is researched, but rather add another dimension, that whilst the specific disciplines are enhanced, a simultaneous effect into community takes place building up gradually the community it finds itself in. This is similar to observations made by McNie et al. (2008) and Dickson (2008). This leads, in respect of climate change, to a less vulnerably society more able to adapt to climate change. To achieve this is a complicated task and different disciplines and different levels will need to be involved.

3.4.4. Multidisciplinary Problems, Multi-dimensional solutions

Science and technology need to contribute effectively to meet the challenges of sustainability (Clark, 2005). To do so the question needs to be asked, what science is necessary and what needs to be sustained. Clark (2005) points out nature, life support and community need to be sustained. People, Economy and Society need to be developed.

Clark regards science that work to be that which is less focused on elite researchers, but rather to put emphasis on empowering stakeholders to increase their options and produce knowledge and end results which will change the behavior of people. Clark suggests pursuing science which will turn into action, achieving goals and avoiding the pitfall of emphasizing the research above the implementation of the solution.

The next question Clark (2005) poses is what kind of institutions can produce the right kind of knowledge. He points out that there is a gap between decisions makers, development workers from Science and Technology and what Science and Technology is producing for them. He further points out the dilemma where often research is not used causing the loss of political support for research. Clark points out that the correct solution to this problem is firstly cognizance of the problem and then the deliberate attempt on both sides to close the gap. For this, Clark suggests "institutional designs of 'knowledge systems' for sustainability". Practically speaking more is necessary. Clark comes from a world where ideas can spark into results as the development of the society is as such that this is possible. With the poor it is not so simple as McNie (2008) pointed out, it is where it often needs to happen one person at a time.

Clark (2005) investigates knowledge systems and refers to existing attempts to close the gap, namely policies, innovation systems, technology transfer and use of indigenous knowledge. With sufficient communication the correct approach can be found for each system. When one combines the arguments of Clark and McNie, it appears a strategy of dealing with development of the poor towards sustainability would be face to face, i.e. as much as possible have people on the ground to communicate, teach, train, enable, face to face.

The question then arose, which systems to follow. Clark points out the systems which are successful, are those that link knowledge and action and then create support systems to grow as needs may demand. He points out how difficult it is to keep dialogue focused, and how easy it is to have miscommunication between different groups and disciplines. Clark emphasizes the systems to strive for are those linking knowledge to action for beneficial outcomes. This is a methodology which is encouraging, innovative with the intent of mobilizing Science and Technology towards answers for sustainability. Clark

looks at programmes and systems which are effective and mention the UK's Tyndall Centre and the Arizona State University programmes. Clark promotes the idea of creating a nexus between interested parties and linking international likeminded programmes to enhance the discussion.

Sustainability centers hold the potential of arrangements which can be made to contain knowledge beyond the life of a scientist at an institution, and continuity of

an idea can grow with the place and project, rather than the people who initiated it. Vogel et al. (2007) point out that such communication links is in effect an information brokering service between the science and the practice worlds and quote Van Kerkhof and Lebel (2006) who stressed the importance of quality information exchanges over time.

Vogel et al. (2007) emphasize how communications can be optimized to form a multi-dimensional grid which can 'scan' an environment scientifically, link up with other information to more expeditiously and productively bring relief and solutions. They use the example of water management, an area which is in the future going to be increasingly important. In this instance the example is used that if time-lines are mis-communicated, decisions are likely to be made without the relevant information which could have guided to a better decision and outcome. It is accordingly important for parties in a specific area where outcomes depend on multiple inputs, that such inputs be coordinated. In this respect, Miles et al (2000) point out the importance of relevant information and the appropriate context for the circumstance.

Vogel et al. (2007) call for harnessing towards solutions, the essence of matching information from scientists, with needs in respect of climate change, and decision making relating thereto. It is in this specific context that a sustainability manager at a sustainability center can be of great importance for future research and outcomes. If these are not to be haphazard, they require management. Currently sustainability is haphazardly managed by chance interactions as need dictate, crisis management, as in the southern African food crisis scenario. However, if a pro-active approach is followed where situations are anticipated and managed in advance through the services of a sustainability manager at a sustainability center, goal orientated outcomes are more likely. This suggestion does not mean to negate the urgings of Cash (2001) and Cash et

al. (2002), that long term interactions are likely to have better common ground and good outcomes, but merely suggest that the scientific world can take a decision to let these important interactions be better coordinated through sustainability management. This will assist in problems mentioned by Vogel et al. (2007), such as scientists lacking certain management skills and similarly industry and government lacking understanding of scientific approaches. In the southern Africa example the authors point out that the communications with non-scientists led to more robust and relevant decision making and such communications can be viewed as part of the skill-set to deal with climate change vulnerability. Boundary organizations may be a place in which to further test and enhance communication between the different sectors of society, to in this way, prepare for the further effects of climate change and make populations more resilient through real life implementation of policies.

3.4.5 Implementation

Implementation of policies was considered. Douthwaite (1999) highlighted that the proof for success of sustainability is an actual improvement of quality of life of those affected, i.e. implementation of sustainability principles.

The most influential foundation for the example of implementation as contemplated in the current research is a paper written for the IHDP in 2007 by Vogel et al. In this study vulnerability, adaptation and resilience science were linked to practice and they looked at pathways, players and partnerships as well as a practical example of implementation during the food crisis in southern Africa. The paper expresses the need for real-world information which can be relied on by all stakeholders. The practical example of the food scarcity in Southern Africa shows different sectors of the community had to function together for the first time to provide food aid. The outcome was communities which were strengthened by the combined approach and the experience opened new communication channels. The authors spell out difficulties experienced from both the scientific side and the practice side. They point out that the notion that it will be easy is a misnomer. However, the study shows that when parties persevere in working towards the same goal, the outcomes can be positive.

Vogel et al. (2007), built on Cash and Moser (2000) who showed the interrelationship between science and practice is complex and multi-faceted when managing environmental society interactions. The latter authors became convinced that the actual getting together and doing had a synergy in itself which came as an added benefit towards achieving the common goal of implementing sustainability principles. McNie et al. (2008) confirms this enhanced effect when goals are doggedly pursued in unity, despite obstacles.

Below follows a synopsis of how this study was approached in light of the above. A specific effort was made to determine the links between society and the institution, and to assess if these relationships led to synergies beyond the original intentions, i.e., did the outcomes of research have a positive effect on outcomes such as health, environment and eco-systems.

CHAPTER 4 - RESULTS OF STUDY

The Results show that all answers on the closed questions posed to interviewees were answered in the positive. See Figure 1 as Appendix 0, which reflects that the interviewees were unanimous in their view that the WRF is de facto a sustainability center.

Further see Figure 2 as Appendix 1 for some of the examples given by interviewees in support of their decisions as set out in Figure 1. Figures 1 and 2 are tangible answers by the interviewees of the questions posed to them, such questions having been based on issues raised by the authors set out in the previous chapter.

Douthwaite (1999) highlighted that the proof for success of sustainability is in actual improvement of quality of life of those affected, i.e. implementation of sustainability principles. The results of this study shows as set out in figure 2, Appendix 1, that this is the case for the community around the WRF. The reader is cautioned that despite the overwhelming outcome of the study, all interviewees pointed out that despite what the WRF has done, it is still situated inside a sea of poverty and disease and so much more can be done if sustainability was approached pro-actively. It was pointed out that a proactive approach may include a due diligence of the region, setting specific goals of

how to overcome the problems. This is in line with what Clark suggested and will also create a vision which can assist in policy making of how to transform the region to sustainability. It is necessary to identify who the role players should be, involve them, and then manage towards sustainability. No doubt the WRF can play an even more meaningful role than it currently does is in this quest towards sustainability. This kind of sustainability envisaged can only take place if someone or a group is empowered to do so. An important aspect of sustainability implementation as set out in the literature discussed previously is that there has to be that someone or groups tasked to manage the process, and it is clear from the results that the WRF as a boundary organization has already made a significant contribution towards sustainability of the region. In some instances it is not so much what the WRF has done, namely what is tangible to see, but what it has done to assist the community to not suffer some of the ills it would have suffered if the WRF was not there.

Considering what the WRF has done towards the management and alleviation of Aids, one can say the presence of the WRF avoided worse disease and even less assistance with some of the hardships and challenges those people face daily. Part of the current debate in South Africa is an attitude which sees the poor as an ever thirsty desert, not worth salvaging. This attitude is born of callousness by the relative few developed and enjoying the affluence on the other side of the ever increasing divide, and obviously completely in violation of the Constitution of South Africa, demanding equality for all. Therefore, despite not formally conducting itself as a sustainability center, through its conduct, the WRF has had sustainability effects which are tangible, as is reflected by the results of this study it avoided even greater hardship for many through its presence over the last two decades.

It is logical that if this is the case, if this recipe is followed pro-actively, that the results will be enhanced if the WRF is formally acknowledged as a sustainability center and deliberately managed as such. To draw an analogy, one can compare a functional and deliberate center to the difference between dropping a few seeds which happen to grow, as opposed to deliberately planting a field which one can tend and reap a harvest from. If sustainability is the problem, sustainability seeds need to be deliberately planted and tended for the best results. The results of the WRF then must be viewed in context. Yes,

as a boundary organization it is clearly positively affecting sustainability. Future need, especially considering the even greater threats posed by climate change, demands deliberate action to be truly effective as set out by Douthwaite (1999).

When considering the characteristics pointed out by Cash et al. (2003), namely:

- Salient - relevancy of interaction being essential
- Legitimate - the organization must not only be seen to act legitimately, but must have the de facto support of the boundary community as an actor which comes with goodwill and legitimate intent
- Credible -a boundary organization cannot be frivolous. It must be an organization which is reliable, particularly if it is to play a role as a conduit towards sustainability, as applied to the WRF, the present study shows that the WRF meets all the above criteria. The WRF is relevant in its interaction and made concrete changes towards sustainability by its presence. The WRF indeed has the support of the local community and is viewed by all interviewed as coming with legitimate intent. The WRF, being part of the University of the Witwatersrand, a highly regarded University the world over, gives it the necessary credibility. This is also reflected in the work ethic and continued support of the WRF. In particular the sustained presence of the WRF at this location is of utmost importance. It is able to produce research which is relevant and done in collaboration with stakeholders, so it reflects the true needs in the community and thus can assist decision makers in sustainability to make good decisions for the future.

Figure 2, which is attached hereto as Appendix 1, shows that the boundaries are permeable at the WRF. It is sustainability in action, working with the WRF are individuals who act as pillars in the sustainability process and play a significant role towards sustainability. The community is interacted, formally and informally, and communication flows in various directions, between policy and science and between society and science. In this fashion the sustainability outcomes are positive, and challenges, including those brought about by climate change, are dealt with in as far as the WRF's current limited role makes it possible.

To expand on the Vogel et al. (2007) idea of a multi-dimensional communication and implementation grid, in terms of the WRF (see below) Figures 3 to 5 (using figure 1) of Vogel et al. (2007), reflecting the multi-dimensional interchanges when applied to HIV/AIDS(RADAR), wetlands (Bushbuckridge Project) and SUNRAE (Sustaining Natural Resources in African Eco-systems). In essence, the WRF shows its efficacy as a sustainability center to deal with the challenges of change and climate.

Figure 3 See appendix 2

Figure 4 See appendix 3

Figure 5 See appendix 4

CHAPTER 5

DISCUSSION AND COMMENTS ON RESULTS

5.1 The WRF's relevance as a boundary organization

5.1.1 Boundary organizations as sustainability-in-action:

An aim was to look at the WRF as 'sustainability-in-action' with reference to Dickson, (2008). She points out that to narrow the gap between boundaries; such boundaries need to be more permeable. The WRF followed research strategies which linked knowledge to action, and stayed focused, as appears from figures 2 to 5 which are a very limited sample of the many WRF projects being undertaken. Projects not dealt with in any detail herein, such as the Agincourt health and population unit, where the association between demographic dynamics and household use of natural resources are researched, and responded to, through educational and other programmes, are also very important.

5.1.2 The linking of knowledge to action

Dickson (2008) raised further questions in response to the linking of knowledge to action. The results of this study on the WRF responded directly thereto and are set out below. The questions posed by Dickson are:

a. Clarity of the boundary organizations tasks by reconciling the supply of knowledge with the demand for knowledge? In the case of the WRF, such as with the RADAR AIDS projects, the research reveals the problem and the science responds with solutions. One such example is a 2007 article by Marris, called "Aids harms the environment", wherein it is described that as Aids takes its toll killing breadwinners, the family left behind has to turn to the natural environment to survive. The reporter commented that such news seems grim, to which the manager of the WRF, Dr Twine is said to have responded "This lends weight to an already increasing call to conserve common property resources. If those touched by AIDS must turn to the land to sustain themselves, it increases the pressure to ensure the land is healthy."

- The WRF constructs and manages hybrids, i.e. sustainability objects which have elements which come from both science and policy such as the collaboration between government and science in the RADAR programme or the SUNRAE /SAEON projects.

- The WRF appears to have the ability to create and maintain spaces between science and politics to the extent that stakeholders can function together yet step back into their opposite roles when necessary such as the DANCED/DWAF community Forestry Project. Science, with the WRF as a base, supported government in a project that was aimed to improve sustainable woodland management and to plan and implement tree planting. The project resulted in the trees being planted and it is reported (du Toit et al., 1999) that the perception of the community towards woodland resources changed as a result of the interactions in the project.

Afterwards government was still government and the scientist themselves, but the intervention left the environment and the community better off.

- The WRF is administered through the University of the Witwatersrand and managed locally with progress and management reports. With respect to sustainability, a formal approach as a sustainability center should have a high level of integrity and sound management as the University of the Witwatersrand is known for its efficiency and sound principles.

- All the results in figures 1 to 5 indicate strongly that the WRF build capacity through its presence in the community.

5.2 Synergies created by the presence of the WRF

This study shows the WRF, as a catalyst towards synergistic effects, enables unrelated parties to work together for better outcomes than what would have been achieved if each acted independently. A good practical example is the RADAR project. Other projects such as SUNRAE are also very impressive. This is especially so if one considers that only a few examples are listed in figures 1 to 5 above and the full extent of the impact of the WRF is not vaguely considered.

5.3 Importance of communication

All results point to excellent communication at all levels. Because so many WRF staff members have made the community their permanent home, links beyond science benefit science.

5.4 Enhancing collaboration

Projects such as set out in figures 1-5, i.e. SUNRAE enhance collaboration.

5.5 General comments

It was interesting to note that each of the interviewees greatly welcomed the idea of the WRF being coined a sustainability center. This was the opinion from all interviewees, whether they were from the organization itself, or from outside of it. It became clear during the interviews that the WRF was a *de facto* conduit towards sustainability but hampered in its ability to set goals in relation thereto because of its formal constraint of not carrying the name of a sustainability center.

This research shows different conceptualizations of growth and hints of tensions and conceptual difficulties, as is likely in the emergence of any new "building". To overcome climate change, workable implementation models must be found (Vogel et al., 2007). The WRF is practically such model and can become an increasingly important conduit towards implementation.

The results show the WRF is relevant in its research and finds solutions around poverty and HIV/AIDS. Research conducted from the WRF shows failures of

Democracy and proper governance, which unpopular as it may be to say so, is best tackled and dealt with till improved.

The WRF, has managed to shape the interplay between the socio-economic and biophysical: The results in figures 1 to 4 show that the WRF's presence has had an influence on human resilience and environmental sustainability.

There is a great need to stabilize eco-systems, as expressed in the Millennium Ecosystem Assessment for Southern Africa (2004), which pointed out that a number of goals, such as child mortality, hunger and environmental sustainability will not be reached unless a pro-active approach is taken. By coining the WRF a sustainability center, a pro-active approach will be taken in accordance with the Millennium Ecosystem Assessment for Southern Africa suggestions.

The WRF is an example of an institution's rural arm, reaching out into a recognized poverty node in South Africa, assisting a community to better adapt to the often difficult circumstances they face. The WRF by its actual presence in the community is helping to mitigate some of the hardships of for example HIV/AIDS and some of the effects of climate change, such as drought. Development in Africa needs many role players. They can only make sound decisions if the information they receive is reliable. In southern Africa development outcomes are uncertain as Zimbabwean conflict over recent years, causing food shortages that went hand in hand with droughts due to climate change, impacting millions for years to come.

Capable partners towards sustainability are necessary. Successful mitigation strategies will depend on such partnerships and it is clear from the above results that the WRF is a reliable partner on these issues.

One or two of the discussions invited by the research showed that the WRF is not necessarily always popular to all, but its presence forces communication to be initiated and problems faced and addressed. What is interesting is that even those who criticized the WRF, wholeheartedly agreed it is relevant, enhancing sustainability and is reliable and legitimate. It appears the reason for the criticism is the terrible need to do so much more. The overwhelming feeling of the community is helplessness and despair in their distress of poverty and ill health, and that they can do nothing about it, but the University of the Witwatersrand through the WRF knows their plight and the perception is there, that the WRF, or the University of the Witwatersrand should do more to help. Much of what is seen in BBR today in the form of mitigation structures and policies and plans towards adaptation has the thread of the WRF's presence (like the Vogel. et al (2007) spiders web) running through it. In this fashion the WRF is like a small stream in the desert, but the hope is there that with deliberate goal orientated approaches a larger flow of intervention will bring more education, better health and life sustaining commerce.

The WRF already plays an active role in preserving the natural resources, some of which, such as water is very scarce. Water is essential to life. The people of the BBR have long periods of dry conditions. Drought conditions have impacted on the region in the past to the extent that crops failed and farm-workers lost jobs and livelihoods (Benson and Clay, 1998). Water scarcity often brings to the fore underlying weaknesses in water security, whether such weakness stems from scarcity, consumption or simmering water feuds. Climate change is a sustainability stressor that is monitored and mitigated by the WRF as a conduit. Soussan et al. (2002) report that the Association for Water and Rural Development (AWARD) in BBR assisted to improve access of poor people to water resources in the Sand River Catchments. AWARD is a project run through the WRF. The author mentions how assistance in water security can assist to alleviate poverty. Ensuring reliable water resources can change livelihoods. Water for basic needs was researched and the domestic water situation analyzed. The ongoing presence of the group contributes to mitigation and adaptation for the people of BBR.

SUNRAE (Sustaining Natural Resources in African Ecosystems) is a research programme run by the School of Animal, Plant and Environmental Sciences of the University of the Witwatersrand, through the WRF. SUNRAE researches and enhances the ecological basis for sustainable rural livelihoods and development. A specific focus is indigenous plant resources and considerations for how land use can affect biodiversity. SUNRAE encourages student training in ecology, and acts as a catalyst for integration and knowledge.

In practical terms, through the presence of the WRF, deforestation is reduced and soil protected. Water is managed better and wetlands sustainability improved. Economic enhancement through biodiversity is taking place as a direct result of the presence of the WRF in the area.

Poverty struck people has often made a livelihood out of the natural environment. When such environment changes, it takes away what is often their only source of income, putting their livelihoods in jeopardy. Development, accordingly, may be affected adversely by changes in the climate. The need to interact on all levels, become essential. Pepper (2003) called for localized interaction (page 25), and the present study shows a practical example of the advantages of localized interaction between the WRF and the community. Some important aspects where this took place, improved the water, health, livelihoods and eco-systems of the community.

In respect of health, the example of the WRF as a rural facility of the University of the Witwatersrand stands out, as programmes developed are now used nationally and even internationally in respect of HIV/AIDS.

The WRF's effectiveness as a leader in a small community towards sustainability was measured in practical terms and the WRF was found to be a good example of localized interaction. The presence of the WRF positively enhanced individuals in the community

in that a number of interviewees who now fill important posts in the community commented that if it was not the example of the WRF, or its stepping stone towards education, or the doors it opened in the market place, they would not have been where they are today. Adding to their own experiences, they recounted numerous other people and groups which benefited as a direct result of the presence of the WRF in the community.

The current study emphasizes that in the struggle against climate change and poverty, sustainability is often not attained yet, but being fought for as part of a collaborative effort by a number of role-players. With high unemployment and increasing effects on natural resources through climate change and population growth (Oliver, 2004), sustainability remains elusive to the people in BBR. The WRF have improved the lives of often indigent people in the area, in practical ways, i.e. quality medical care and programmes on how to deal with HIV/AIDS.

The aim of this research was further to look at the WRF as 'sustainability-in-action' as called for by Cash et al. (2003); Vogel (2005); Vogel et al. (2007) and Moser (2008). The University of the Witwatersrand through its rural campus at the WRF has a presence on the border of the developing world. The interactions with that world create a conduit to guide and assist the society to move towards sustainability on a number of fronts. People are better able to deal with HIV/AIDS. Because of the WRF's presence the community is finding new ways of dealing with the ecosystem in order to preserve it. The WRF is empowering people to be more sensitive to the need for good governance. The WRF is actively adding to sustainability.

An ideal boundary organization would have its ear to the ground, so to speak, sensing through its interactions concerns developing, or impacts on the society. To effectively do so, would require being alert on as many fronts as a society exists on. The BBR population eek out livelihoods mainly from subsistence farming and rely heavily on state

support. Health, socio-economic ills and shortages of food, water and sanitation is common. The sensitivity the WRF needs to display is through research that is sensitive enough to notice a shift in any direction. Practically the WRF is succeeding in respect of sensitivity to needs.

With climate change on the increase, the WRF needs to be sensitive enough in its research to ring alarm bells early, so that mitigation in a specific area of concern can be addressed timeously and effectively. This it has done. As an ideal sustainability centre it should have tentacles that connect closely to all aspects of the community and ecosystems. Figures 1 to 5 show that the WRF does just that. In this way the WRF reduces the vulnerability of the community in the face of climate change.

Due to its longstanding presence in the community and the many friendships now weaving a net of goodwill between the developed world people at the WRF and the developing world neighbours, WRF people are deeply attuned to the impacts and changes of the BBR community. Its research is further sensitive as is displayed by Agincourt results, where research uncovered the needs of a highly state dependant society.

Sustainability into the distant future without intervention is, as Thornton pointed out, unlikely. The WRF has played a significant role in bringing awareness of the situations the BBR's people have faced. The WRF mark on the landscape is evident in a number of factors making the society more sustainable. Sometimes the influence is so subtle that unless the right questions are asked one would not know that the WRF or someone from the WRF played a role. Examples are: a traditional healing nursery, a bee farming business, a marula oil manufacturing plant, to mention a few. Even infrastructure has been influenced by the WRF sharing of knowledge, pointing out the needs, enabling national and local government and non-profit organizations to develop projects at schools, the hospital, provide boreholes, sanitation, access to clean water, to mention a few examples.

The approaches formulated over the years by the WRF are practically workable, but so far they have been (at least officially) purely academic in origin. The links which have made for greater resilience in the community often came from individuals stationed at the WRF reaching out into the community in their personal capacities, finding solutions to the problems they encounter by helping locals get started (for example a project with a herbalist nursery). Communications of friendships and volunteering does not know the boundaries of formal academic structures. If the improved communication Vogel et al. (2007) suggest possible is going to take place, institutions may want to encourage the wider relationships, which in the case of the WRF was a natural result of their presence, yet have impacts in making people more resilient. As McNie et al. (2008) found, this research shows the dedication of people linked with the WRF for a long time and how their perseverance has created relationships of trust, which makes for improved chances of reliable science and implementation.

Boundary organizations can therefore stimulate communication. There is energy about most of the people at the WRF, which carries beyond their formal careers and find expression with relationships and uplifting private activities into the community, as is evident from the results. The conclusion is that the members of staff are often enthusiasts, or embedded boundary agents as the literature describe them, which carry the center to that extra level where it becomes more than a traditional rural campus.

However, the first main impact on the community remains the official one, namely the positive formal effects of the WRF in the greater community. The communities' overall ability to adapt comes from the sound research of the University of the Witwatersrand through the WRF, translating into solutions and making for better adaptation and mitigation. What perhaps takes the communication beyond its usual limits is that the WRF is staffed with highly educated and able people in close proximity and with continued interaction with the underdeveloped. As trusting relationships form over years, those that can, develop the information gained to practical situation sensitive solutions,

because they truly know and truly care. At present the fact that such people often reach out in their personal capacities is an added benefit to the community and university. The communication Moser and Luers (2008) call for, therefore is taking place at the WRF.

Creating partners towards more effective policy making and governance as Jasanoff (2008) urges should happen, is given effect to practically at the WRF.

This research produced different conceptualizations of growth and hints of tensions and conceptual difficulties as well. Various authors discussed previously, commented on the potential of tensions on the border. This is likely in the emergence of any new "building". The representative of a chief interviewed felt frustrated that they were studied as opposed to being helped financially, despite studies showing the clear financial need. As an academic institution the WRF is contained to its academic program and that is hard for the indigent to understand. The expectation they have is that once they have told someone at the WRF the solutions will follow soon. Developing policies and implementing solutions take time. Even though solutions followed in areas such as health and eco-systems, the area is largely unemployed and cash strapped, which means the financial deprivation in the form of creating more employment for the area has not followed. A formal classification as sustainability center should solve many of the problems created by the more formal approach. Therefore, in practical terms where the WRF's formal presence creates friction, it still results in dialogue, which can lead to positive outcomes.

Money was found to be a concern at the WRF as well. A number of people expressed frustration that the main University in Johannesburg from time to time shows reluctance to carry the cost of the WRF and often sees it as a millstone around its neck, decreasing budgets or even stopping certain funding. It appears the perception is that certain power structures at the university feel there is so much need in and around Johannesburg with run-away urbanization that the funding can be better used around the main campus rather than in a rural area. However, the most socio- economically affected individuals in South

Africa are rural women. The WRF operates in an area such as this. By withdrawing from the WRF the University will loose a great deal of past input, established programs, and the world-wide name as a conduit for rural study. A formal classification as sustainability center should solve many of the problems created by the more formal approach. Therefore, in practical terms where the WRF's formal presence creates friction, it still results in dialogue, which can lead to positive outcomes. With the RADAR AIDS project this is already a practical reality.

The real measure of success for the WRF as a sustainability center was to establish how tightly interwoven it was with the community. This study shows the WRF is an integral part of the community it finds itself in, and it has been measuring the pulse of the community, commenting on ills, suggesting solutions, partaking in creating technologies for solutions, tweaking results and seeing the impact of its presence, for instance through the Aids Radar program. There is no doubt; the WRF's existence has made the community more resilient and better able to tolerate its circumstances.

It was found that the WRF staff is more aware of what it has done to overcome problems than some of the community representatives. The latter are not blind to the solutions already found, or the impact in their lives. Because they live in poverty, disease and lack of resources and work, their expectation that an organization such as a university can make a difference is an emotional one, because they put so much hope in it, the only beacon of light in a sea of distress. It would be no different than sending one ambulance into the scene of a multiple car crash. All will be happy to see it and the expectation is they will be helped in their particular needs, whereas limited capacity allow for only so much. Unless expanded significantly with a specific objective towards planning for especially commercial sustainability, the WRF and its people can only do so much. Even those who expressed the desire that the WRF should do more, and be more involved, positively answered all the questions, namely that the WRF is already sustainability in action and even volunteered examples to support their answers. The fact that there was

expression and desire that more should be done, should not derogate from the fact that much is already being done by the WRF.

This study shows that the interviewees unanimously agree the WRF is a *de facto* sustainability center already. The information gained will hopefully assist the WRF and its mother institution, the University of the Witwatersrand, to realize its importance as not only an academic institution, but its impact practically on sustainability in the community it finds itself in, with the potential of being much more in the future. The world has finally put the needs to balance development and environment at the top of its agenda and the WRF is well poised to play a significant role if the University of the Witwatersrand will enable it to do so.

In the assessment "negative gaps" were identified, namely opportunities which have not yet been taken in the WRF as a centre towards sustainability by a boundary organization. In the architecture it was imagined that for an effective boundary organization, cognizance must be had for the issues creating the boundary. It must further be identified who the stakeholders are. To establish the level of proximal interaction indicators such as proximal collaboration, between stakeholders should be considered. Inside this framework, the perspective must not be lost that to date the WRF is first and foremost an academic institution with its core function as academic, and accordingly the example it sets by being on the boundary is exemplary, but the WRF cannot be measured or considered as if it was created for the purpose of sustainability, as it was not. The study shows though, that it lends itself well to be wider tasked, but formalities and funding will be necessary to do this.

Because of the WRF's current limited role there is frustration on both sides, and as stated before, much of what has happened in the smaller projects scattered all over the area (honey farming, marula oil, etc), is with the personal time and efforts of WRF employees or people who came to the WRF for academic reasons, but in their personal capacities.

The links of knowledge and action are accordingly there, but the knowledge begs for more action, more people. To bring such action into reality will however require a specific decision by the University and in need a study as to how the WRF can be converted to an official sustainability center. Such study can address who should be tasked to do so, who the partners should be, long term goals, etc. What will be important is for the WRF to not loose its current momentum and abilities, so any expansion towards a sustainability center should be a gradual well calculated adding on, rather than a changing what there is and establishing something new. The adding on should be based on need. With such model, the problem is climate change, where the need is urgent. The logical conclusion is for the WRF to make its facilities available broadly, so that the multi-dimensional structure it already has can continue to capture information and be sensitive to needs, but with greater and more urgent emphasis on climate change and sustainability.

This study shows that the first and foremost shortcoming of the area is a lack of commerce. The commercial society is an integral link towards sustainability. If one had to take the three strands of society, the public, private and commercial sectors, the WRF is a strong link between public and private, but without the commercial sector weaving into this meaningfully, what can be done will be limited. A good example of commercial ventures taken to rural areas and active in the area of the WRF, is the Plum Systems (a South African telecoms company) which developed a system which enables entrepreneurs in rural areas to become distributors of airtime, sell voice calls and perform banking functions with a low financial entrance cost.

Policy formulation of science does not necessarily lead to implementation thereof. There is a need for communities to be made more resilient and this means they have to be more involved in factors that influence them, such as climate change.(Vogel, 2005; Jasanoff, 2008; and Moser 2008). On this important aspect the WRF is playing a leadership role as it has high community involvement and exposure. Healthcare has been greatly enhanced and the fight against Aids is significantly impacted by the WRF's long standing research.

Such research has influenced policy making, driven and collaboration towards implementation. Follow up research has been able to show shortcomings and monitoring implementation. The WRF has an office at the Tintswalo Hospital and accordingly its community involvement is first hand and long standing. Also impressive is the raising up of various individuals in the community who took the knowledge imparted by the WRF and turned it into meaningful projects, i.e. a school getting all the parents involved in planting trees and tending gardens, or people developing personally to leadership roles in hospitals and community projects.

In our Common Journey: A Transition Towards Sustainability (1999), it is pointed out that there is a great need to navigate towards sustainability. The enormity of the task is highlighted in the following quote: "…the Board focused its efforts on the next two generations, when many of the stresses between environment and development will be most acute and when a transition towards sustainability will need to take place if the earth's human population and life support systems are not to significantly damage both". Climate change is now impacting the situation further. The current study was accordingly an opportunity to examine how functions and purposes have developed in the WRF in line with criteria considered as important for sustainability. Such criteria may be: education, health, poverty, crime, jobs, natural resources, materials for production (Hart, 2000).

The concept of single individuals playing key roles in sustainability is important, as many communities have enthusiasts who do not necessarily represent an organization when they serve the community or interact with the community, getting to know it better, in his or her free time. For such individuals who are part of an institutional boundary organization, recognition of their activities is important because often professional careers need long term tying up with wider societal goals. If recognized and encouraged such professional person can become an effective instrument towards sustainability (McNie et al., 2008). The individual, having one foot in the institutional boundary organization and the other as a new member of the community it seeks to serve, becomes

a bridge towards effective technology transfer. Part of the institutional architecture of the WRF studied, was the relevance of the activities of individuals and their contributions towards sustainability in the community. Conclusions are drawn from examples given by interviewees.

5.6 Conclusions considered in terms of the literature

Pepper (2003) called for localized interaction (page 25), and the present study is a practical example to measure the WRF's effectiveness as a leader in a small community towards making it less vulnerable with the anticipated effects of climate change and sustainability. Jasanoff, (2007) highlights the importance of managing the risks of a world on the brink of globalization, especially as relates to the developing world at local level.

Roger Kasperson (2005) pointed to the divides between science and policy or practice and the need to build connections in practice. The six problems which he highlighted are:

- A knowledge mismatch, where the knowledge produced may not be the knowledge needed - as such this study on the WRF shows how 'tweaking' of programs to accommodate real needs took place because the academic institution sent out the WRF to establish an offshoot into the boundary where it could ascertain the need much quicker than was likely to be the case otherwise (RADAR program for Aids –see conclusion below).
- Knowledge signals and interpretation being re-formulated and changed by for instance the media, moving what was important to oblivion
- Lack of goal orientated solutions to problems
- Mismatches in speed or policy in dealing with problems
- Policy formulation of science does not necessarily lead to implementation thereof
- There is a need for communities to be made more resilient, and this means they have to be more involved, not only the decision makers - on this important aspect the

WRF can play a leadership role as an example towards dealing with the effects of climate change, true sustainability and community involvement. The main solutions which Kasperson (2005) suggests, and this supported the contentions of Vogel (Vogel, 2007), that social learning and knowledge is crucial to produce knowledge which is useable. To do so requires

- Problem-specific science
- Collaborative processes
- Learn how to integrate local (expert, indigenous) knowledge into scientific knowledge
- Pursue value centered knowledge which simultaneously retain traditional concepts such as high standards

Having examined how these themes emerged in relation to the WRF, provided a practical case that the WRF has truly been science in action in the way it meets the requirements set by the theoretical debates highlighted above.

Bierman (2006) suggests new public private partnerships beyond the traditional between state and inter-governmental agencies. The summary of some of the results of this study of examples to substantiate their answers by the interviewees, show how the WRF has practically fostered public private partnerships at the WRF. This is a practical example of Bierman's call that: "Despite a growing body of literature, the legitimacy of non-state actors, including whether private involvement in global decision-making fosters or harms the ideal of global democracy, has not yet been sufficiently analyzed." In its own eyes the WRF has merely been a base from which to conduct scientific research, whereas its potential, its practical application as a tool towards sustainability, is far greater. Vogel et al. (2007) pose the question how some of the issues pertinent to climate change and sustainability can be addressed pro-actively. The authors lament how where sustainability is most needed, there is often a non-existence of truly representative civil society forums to communicate with as a formal base to tackle climate change. Vogel et al. suggest that perhaps boundary organizations can play a role as a links between society, science and

government. This research shows how in practical terms the WRF fulfilled such position to the community it finds itself in.

The question now is if the WRF would accept the challenge and turn the factual situation into a legitimate one, by declaring itself a sustainability center with a sustainability manager, to in a coordinated and deliberate fashion tackle sustainability and climate change for the region. This does mean a moving beyond its boundary as merely a center for learning, but perhaps that is the demand climate change will force on institutions such as the WRF. The pro-actively dealing with climate change and sustainability issues, according to the authors referred to, will require collaboration beyond traditional government policy. Society, commerce, institutions and governments will have to collaborate to make communities more resilient when facing the increased effects of climate change. Guston (2001) point out that hybrid ways of dealing with solutions are not well examined at all. The call was made for practical examples such as this one. Each investigation is a step towards better knowledge.

Until sustainability outgrows its childhood fears the goals will not be reached. Whilst sustainability takes pictures of the gaps as an advertisement to mobilize those with the power and money to give it life, it will be too unpopular to succeed, to the extent that in many circles the word “sustainability” is no longer used! It is only when those who can market it as attractive, take hands with those who have the money to finance it, take hands with the science which can figure out what is wrong in a particular society, preventing sustainability, how to fix it, who should fix it, when, with what, and take hands with the politicians, commercial structures and communities to form a universal collaborative effort, only then will sustainability start happening on a wide front. This study aimed to give a snapshot of the WRF, of what happens practically when those factors cross paths, even in a limited unintentional fashion. Decision makers should consider what if the WRF is more deliberately managed and funded sustainability programs, whether it can build on the foundations already there to play a deliberate role

in global sustainability. It was considered if diverse disciplines and stakeholders may need to unite towards the common goals of sustainability to see a true transformation.

To achieve the goals of sustainability as much of a disciplinary mix as possible is necessary. Is this a process which will be enhanced if deliberately managed? Sustainability management will remain unpopular whilst the perception is there amongst those on the ground implementing, that it is someone else lording over them. Sustainability management therefore needs to be tackled sensitively, but with determination and urgency and it is hoped this pilot study will pave the way for a larger study to study the nuts and bolts of the WRF as a working sustainability center on the ground, where the action is, so it's successes may play a role in future decision making and may become a valuable tool in dealing with climate change at local level. As with all pioneers breaking new territory, such territory is only gained by being an example: by walking out in front and showing the way. The WRF was examined to see if it is such organization of people with willingness and an understanding of how to do it: how to let sustainability become reality. It was found to be the case.

The effects of climate change are increasingly real and bring urgency to finding solutions and mitigating strategies. Platforms will be necessary from where to manage and deal with climate change. Sustainability centers may be a partial answer and because of the urgency and relevance of the problems of climate change, climate change is considered in the current research, measuring the WRF for its current and potential relevance as a boundary organization beacon in a particular area, measuring and mitigating climate change practically.

CHAPTER 6 - CONCLUSION:

The important knowledge to take away from this pilot study is that the WRF is in essence knowledge in action, making sustainability more attainable. The study is a practical

example of what Clark (2005) suggested, namely that the divides between the developed and developing worlds need bridges to close gaps. Practically speaking, the WRF is such bridge.

The WRF "bridge" is one between (at least) two divides. The one divide is between science and politics. The other divide narrowed, is through its physical presence as a practical sustainability node. In this way the WRF bridges the gap between the developed and developing worlds.

Centers like the WRF are necessary. as the literature review pointed out, as they act like glue between the two worlds. McNie et al. (2008) pointed out specifically how the developed world has policies in the wider term, whereas success in the developing world is forged one person at a time. This implies large numbers of enthusiasts {or "embedded boundary agents", as McNie et al. (2008) call them!}, who need to be raised, trained and put in the field, to man sustainability implementation centers so that 'one on one' can happen. In short, the concept of participation in sustainability efforts needs to be popularized to draw people in large enough numbers, especially from the developed world.

As to the border between science and policy, the WRF is an example of synergistic interactions, leaving the parties their own autonomy on the other side of the event. An example is the RADAR project where the university retained its own identity and it and government synergistically created solutions to combat the hardships of HIV/AIDS.

More people are necessary on these borders. When sound academic foundations are implemented pro-actively, much become possible. The truth is though that many do not want to be so close to the dust, dirt and diseases often associated with poverty. It is much easier to write academic articles than to get your hands dirty. In essence the scientists who live on the true border experience the hardships of it and it appears, as was reported by McNie et al. (2008), that they develop a new energy and commitment to become bridges through personal relationships and trust. What one therefore needs on the border are people who are truly committed to making a difference and with the tenacity to see the process through. It means that even though the research done for one two or three years is important, but essential is those who make such station their long term goal and

home, so that long term research, sometimes over decades, can take place and so that continuity may be achieved.

What was gained from this research as a personal take home, was seeing people who love their science, but love their neighbour even more in the vein of "I was hungry and you fed me, I was thirsty and you gave me something to drink."

The science and technologies are there to enable the undeveloped to use solar,

i.e. with parabolic cookers, and for lighting homes; or water-less sanitation methods; or simple methods to make drinking water safe; or even re-kindling traditional building methods with low impact on the environment. However, until the leadership is there to make these ideas attractive, or commercial partnerships are forged to build factories which could even export technologies and products, the success will be stunted and dealing merely with the ills, instead of setting goals for true sustainability. Those that have the ability should seek those who have the desire to forge the necessary partnerships to meet the challenges described herein. Only purposeful management of the sustainability process will achieve results leading to true sustainability for any particular region. The WRF is a practical example that setting and achieving goals which lead to sustainable outcomes, is possible.

Whether management of the process is achieved through the appointment of a sustainability manager, or a team of people from stakeholder groups, in order to go beyond the results described in Figures 1 to 5, true sustainability for the area in which the WRF finds itself, will require even more determined management. Current results should be applauded. Dedicated and long term people who forge sustainability on the frontier, who are deeply committed to conduct the research to uncover the needs, and have the know how and tenacity to drive solutions, must be empowered to bring about sustainability processes. On the foundations set out for boundary organizations as highlighted by Cash (2001), and Cash et al. (2003), the WRF qualifies practically in terms of this pilot study as a sustainability center.

The biggest benefits of officially declaring the center a sustainability center will be that a coordinated approach towards sustainability will become more likely. Even though the principles already guide the University, deliberate management in that direction is likely

to produce even better results. The technologies are there to assist the developing world to skip the industrial age and enter the developed world using renewable energies and technologies and services which lead to better health and improved socio-economic circumstances. This will not happen without deliberate effort and a determined approach to expand on the essential role of commerce in the process.

The most important potential of the WRF, lies with sustainability management, namely proactive efforts to forge solutions to needs. A gaping wound in the area the WRF finds itself in is the lack of true and sustained viable commercial activity. An appropriate example would be to deliberately manage towards a greater commercial presence in the area for job creation and relief from poverty. Twine and Hunter (2008) show how HIV/AIDS and the environment interact in complex ways via affected livelihoods and human and financial capital and how natural resources becomes a buffer in the form of food and energy security and cost savings. However, such natural resources are already compromised (Shackleton et al., 2008). The recent words of Sir Mark Moody-Stuart, Chairman of Anglo-American, speaking at the Leadership Conference on Global Corporate Citizenship, March 2009, are accordingly welcomed "Business is not Government and must not seek to appropriate the role of Governments. But where a multinational company like Anglo American has a major presence in the developing world, we become *de facto* an important development actor. Often there are multiple local needs: a lack of basic health care, education, and infrastructure. Or even simply a lack of food. Business must act as a partner to help meet those needs. Why? A healthy population means a healthy workforce; an educated population means a skilled workforce; a prosperous population means a motivated and supportive workforce."

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APPENDIXES

Appendix 0 - Figure 1

Appendix 1- Figure 2

Appendix 2- Figure 3

Appendix 3- Figure 4

Appendix 4- Figure 5