

The Role of New Technologies in Potable Water Provision:

A Stakeholder Workshop Approach

Can Nanotechnologies help achieve the millennium
development target of halving the number of people
without access to clean water by 2015?

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Report on the Nano-Dialogues held in Harare, Zimbabwe,
15, 16 and 22 July 2006.

"We hope one of the
outcomes will be a
sustained dialogue
between scientists
and end users that
enables new
technology to deliver
on human needs
rather than be driven
by market wants."

Globalisation and the diffusion of
nanotechnologies to help the poor



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Executive Summary

In 2006, researchers from Demos, Practical Action and the University of Lancaster collaborated on a process designed to engage Zimbabwean community groups and scientists from both the North and South in debates about new (nano) technologies.

The dialogue was one of four experiments, collectively referred to as the nano-dialogues, in public engagement with nanotechnologies, funded by the Office of Science and Technology's Sciencewise programme. Sciencewise was created to foster interaction between scientists, government and the public on impacts of science and technology

The provision of clean water to both rural and peri-urban communities in Zimbabwe is complex. The systems approach to the analysis and reflection on the topics discussed in the dialogues has enabled a comprehensive capture of the complexity and inter-related issues in relation to the presenting problem.

The modelling of the problem situation was particularly helpful in articulating the sub-systems needing discussion. The dialogue was able to focus on the three sub-systems of water supply, culture, and technology. Further, we were able to focus on both economic and behavioural changes required.

The multiple stakeholder approach to the dialogue worked well with all those involved being able and willing to participate fully.

At the end of the second day the tentative conclusion that: "there is no real water quality issue that cannot be solved with existing technologies" was agreed but this was not the consensus at the end of the three days.

There are a number of outstanding issues that the workshop could not resolve. These include:

- Questions for scientists to answer - summarised on page 10.
- Whether existing or new technologies were needed to solve the presenting problem.

The overall recommendations of the workshop are outlined in Table 3 which shows the recommendation in relation to the critical issues identified and states who needs to be responsible for implementation. The six critical issues are:

- Affordability
- Resource mobility
- Awareness
- Acceptability
- Sustainability
- Policy framework

The role that new technologies generally, and nanotechnologies more specifically, can and/or should play in the provision of potable water is the subject of a continuing debate. The way forward will need to take account of the risks and costs in addition to the opportunities for real benefits to poor people. Water is a local resource and as such any intervention that is designed to improve the quality of that resource will need continued involvement of scientists and local communities.

Background

In 2006, researchers from Demos, Practical Action and the University of Lancaster collaborated on a process designed to engage Zimbabwean community groups and scientists from both the North and South in debates about new (nano) technologies.

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Governments, companies and NGOs are all talking about Nanotechnology as "*The Next Big Thing*". Alongside the promise of new worthwhile opportunities comes uncertainty about risks, ethics and the benefits to those people who are too often left out of conversations about the ends of technology - the poor. The potential benefits of the applications of nanotechnologies in developing countries are exciting. But the conversation linking the needs of people in developing countries to the resources and scientific knowledge of researchers around the world needs to be nurtured.

In the UK, nanotechnology is being seen as an opportunity to have an earlier and more open debate about emerging technologies, to avoid the antagonism and distrust generated with Genetically Modified (GM) foods. The Government are supporting the Royal Society and Royal Academy of Engineering's call for "a constructive and proactive debate about the future of nanotechnologies... at a stage when it can inform key decisions about their development and before deeply entrenched or polarized positions appear." (Royal Society 2003). The nano-dialogues are a set of opportunities for early public debate. One of these aims to engage communities in Zimbabwe in discussions about emerging technology.

Views about the relevance of application areas for poor people converge on two sectors, namely water and energy. These were the sectors, according to an international group of experts convened by the Meridian Institute to advise a Rockefeller project, thought to be where applications of nanotechnology are likely to bring potentially beneficial products that could offer solutions for poor people. According to one recent study, the top three applications that would help developing countries are: energy storage, production and conversion; agricultural productivity enhancement and water treatment (Salamanca-Buentello *et al* 2005).

We have chosen water treatment as a focus for our dialogue. First, in development terms it is a well established priority. Second, technology is at a stage where it may be able to make a significant contribution to filtration, and decontamination. The Millennium Development Goal is to halve the proportion of people without sustainable access to safe drinking water and basic sanitation by 2015. Our dialogue seeks to introduce the views and values of people for whom clean water is an everyday problem into debates about possible technical solutions. By involving scientists who are engaging in leading research we can move the debate upstream. We hope one of the outcomes will be a sustained dialogue between scientists and end users that enables new technology to deliver on human needs rather than be driven by market wants.

Methodology

Our dialogue builds on Practical Action's experience of engaging people in developing countries in debates about new technologies (Rusike 2005). We conducted the exercise over a two week period in 2006 (15, 16, and 22 July), involving local individuals, scientists from the North and South, and policy-makers.

The quest to ensure that all people have access to clean drinking water is now

enshrined in the MDG's. Often approaches to providing water for poor communities have been driven either by economics or technology. The economics route might typically centre on the importance of regulations, institutions, and open markets. Whilst the technology approach might focus on designing a water pump, filter system, or novel application of nanotechnology. Yet we know that the technology for providing clean water has been known about and in use for thousands of years (for example the Romans around 300BC). Failure to solve the issue might also be seen as a cultural or indeed political or managerial problem.

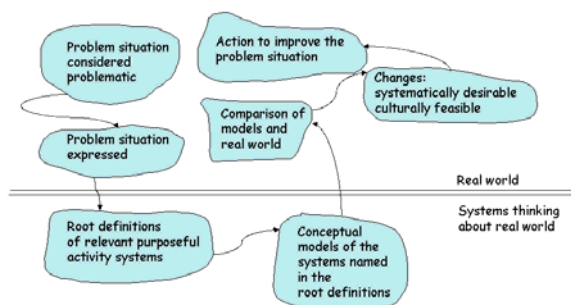
In recognition of the above characteristics of the problem domain we shall take a systemic approach. Many complex problems in science, engineering, or indeed other fields have some characteristics in common. Hard systems approaches have sometimes failed, for example, in the case of the Challenger disaster in 1986 when the space shuttle exploded moments after take-off killing all seven crew. Was this an engineering failure or one of managerial or political failure? McConnell (1988) says the emphasis at NASA had shifted from technological considerations to managerial, commercial and political ones. This is a good illustration of the way in which we frame problems effects the outcome in terms of the activities that take place to solve the problem situation. Two lessons are taken from this story: first that in complex problem situations a systemic approach has proved worthwhile; and second that "what in fact made the situations ill-defined was that objectives were unclear and that both what to do and how to do it were problematical." (Checkland & Scholes, 1990)

The dialogue took a soft systems approach which can be depicted at its simplest level in Figure 1.

The essence of the soft systems approach is that it allows a natural dialogue to take place with the facilitators using the

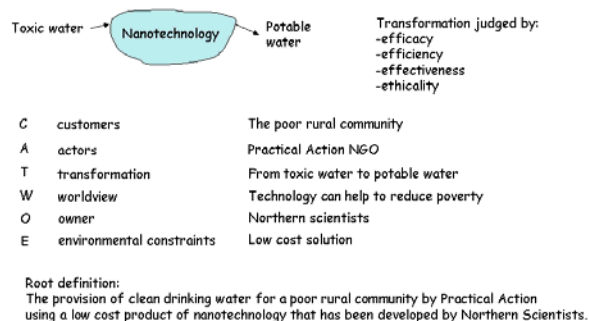
methodology to capture and keep in a systematic way the outputs of each session.

Figure 1 Soft Systems Methodology: Overview



The problem situation was captured during the workshop held in Zimbabwe. The workshop facilitators ran a two day workshop, with the activities outlined in Appendix 3. Before the workshops a root definition and CATWOE were conceptualised, ready to be tested with the real dialogue during the first two days of the workshops. Figure 2 gives an example of this kind of output, for reference.

Figure 2 Capturing the Problem Situation

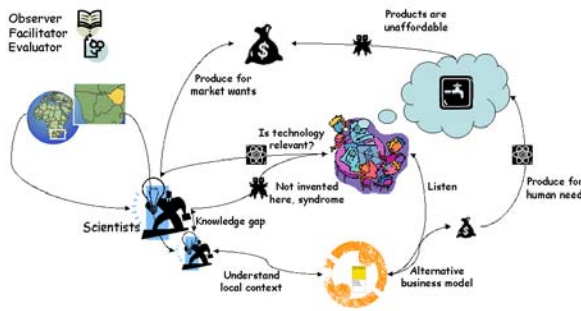


Our approach was to build on Practical Action's experience of engaging people in

developing countries in debates about new technologies (2005).

Figure 3 depicts the problem situation in the form of a rich picture. During the first day of the workshop this rich picture was drawn by the organisers as a reflection of the problem presentation. The idea of the rich picture, very simply is that it can convey relationships and connections much more clearly than prose.

Figure 3 Rich Picture of the Problem Situation



In the problem situation identified there were several sub-systems. The model in Figure 4 illustrates the idea. Figure 5 shows some possible interactions between these three sub-systems, with each sub-system being shown in a different colour. The conceptual model shows a set of activities that would realise the root definition.



Spring Water, Epworth, Zimbabwe

Figure 4 Sub-systems

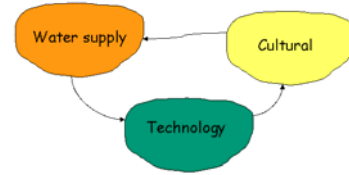
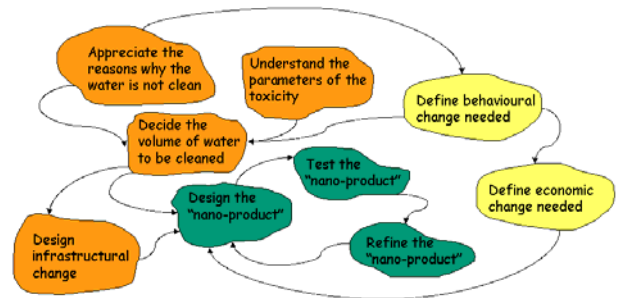


Figure 5 Conceptual Model



Reflection on the Methodology

Academics might ponder such questions as: Is the methodology any good? Does it work? But in the “real world” most people recognise the need to find a methodology that works for them and get on with it.

“if a reader tells the author, ‘I have used your methodology and it works’, the author would have to reply ‘How do you know that better results might have been obtained by an ad hoc approach?’ If the assertion is: ‘The methodology does not work’, the author can reply, ungraciously but with logic, ‘How do you know the poor results were not due simply to your incompetence in using the methodology?’ Checkland (1972:114).

In that spirit we got on with it. What follows is our account of that dialogue.

Stakeholder Panel Workshop



The stakeholder panel workshops were held in Harare, Zimbabwe during three days: 15 & 16 July (followed by a gap of a week) and 22 July 2006. The full timetable can be found in Appendix 3 and a list of people who attended can be found in Appendix 1. The workshop was opened on the first day by the Deputy Minister for Science and Technology (the opening speech can be found in Appendix 2).

Day 1

The Deputy Minister made it clear that he would welcome recommendations from the dialogues that would help science and technology achieve development objectives in Zimbabwe.

The workshop began with some brief statements to encourage the participation of everyone on an equal basis. The overall goal was to contribute to the millennium development goal 7: "ensure environmental sustainability". A key target of that goal is: "to halve, by 2015, the proportion of people without sustainable access to safe drinking water". With less than 10 years to go and with more than 20% of the world's population still not having access to safe drinking water we were clear of the enormous challenge but reminded that, "you can only change the world one conversation at a time".

To solve the problem of a lack of potable water we needed to identify the impediments to the goal. This we could do in simple stages, focussing on the "what?", "who?" and "how?"

"You can only change the world, one conversation at a time"

Susan Scott (2003)

The session continued with each participant introducing themselves and saying what their expectations were and what their perceived contribution was. We were conscious of the fact that merely holding the workshop might raise expectations amongst the two communities that some resolution of their current water supply problems might be imminent.

The presenters made it clear that whilst the objectives (see panel) specifically mentioned new technologies, it had to be recognised that the technologies that could deliver clean drinking water to people have been available for thousands of years. Therefore, the dialogues would need to take a wider view of technology that encompassed both people and processes. The challenges were recognised to be great but achievable with all the relevant stakeholders present.

Two groups were formed: scientists and communities to further the discussion in a safe environment. -Each group was given the following four questions to structure the discussion and report back on in a plenary session.

In what areas of your life would you benefit from new water related technology?

What do you see as hindrance to society's uptake of new water-related technologies?

What do you consider to be your role in quickening the uptake of new technologies?

Which water related technologies have you found to be beneficial to your community?

The main points from each of these groups have been captured in Table 1 (see Appendix 4).

Further capturing of the views of stakeholders was done in a single group in the afternoon of day 1. The discussion was taken forward by use of flip charts with diagrammatic representation of three inter-related areas: water supply, technology and cultural context. One chart was produced for each of the communities. Figure 6 shows the main issues in the rural community and Figure 7 shows the issues from the point of view of the peri-urban community.

some differences between the two communities. These are best illustrated in the photograph, taken at the workshop, which shows the differences and similarities between the two communities.

Water Supply		Technology		Community Involvement/Context	
Rural	Peri-Urban	Rural	Peri-Urban	Rural	Peri-Urban
Water is not portable	Water is not portable	No capacity to maintain or repair technology	Bring technology to the household	Involve community in introducing new technology	Engage with local planning authorities
Supplies are insufficient	Supplies are insufficient	Need to address Salinity issue	Need for sanitation solution for Peri-Urban	Involve software in programmes (capacity, education, etc.)	Involve community in introducing new technology
Distances to water points are too long	Contaminated by industrial effluent	Need for protocol governing the use of new technology	Lack of funds for new technology	Need for inclusion of science dialogue in policy	Need for inclusion of science dialogue in policy
Salinity of water	No of people per water point	New technologies must be disseminated	Looking for technology to protect well		
Contamination by industrial effluent Excess fluoride	Contamination by proximity of waste to latrine	Bring technology to the household	Equitable share of clean tap water (communal)		
		Lack of funds for new technology	Cost of water treatment is high		
		Provision of education services for new technologies	Use appropriate technology to prevent contamination of wells		

Figure 6 Rural Community

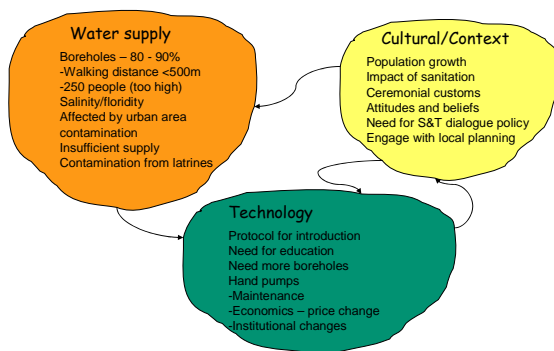
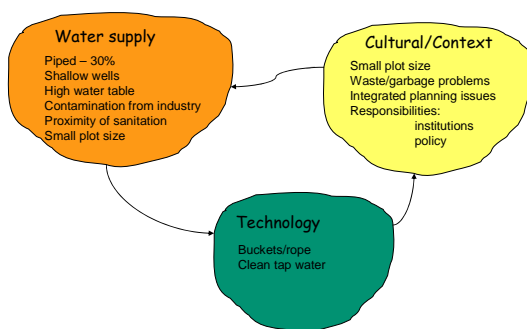


Figure 7 Peri-Urban Community



There are a number of similarities, but also

Day 2

The day began with a recap given by the facilitators. We then continued discussion on technology issues, prompted by the question: "what are the key water technology problems?" It was recognised that some technology problems might have an economic component (see the conceptual model in Figure 5). Technology and Economic issues were captured on a flip chart.

Technology issues:

What are the key water technology problems?

Rope and Washer pump has the following characteristics:

- <20m depth
- Low cost
- Well needs protection

Constraints of this technology are:

- Availability of well
- Well lined
- Cost of cement (Z\$12m)
- Rope (30m) (Z\$3m)
- PVC (15m)
- Knowledge

Eco-San has the following characteristics:

- Waste used as a resource
- Slab structure
 - Trees can be planted
 - Ash added
 - 6-8 months for a pit/alternate 2 pits
 - Reduces use of water
- Permanent structure
 - Add soil/ash to aid degradability
 - Compost
 - Fluid - fertiliser
 - Solid - soil conditioner
 - Household based

Constraints of this technology are:

- Cultural/mind shift of government
- Knowledge dialogue
- Cost
- Approval of local authority

Sand Abstraction System has the following characteristics:

- Filtered naturally
- Low material cost
- May need pump
- Pipes may clog
- Surface pollution
- Needs some further research
- Quality ground water supply
- Predict water quality
- Used in Matebeleland
 - No pump used
 - Some manufacturing in Bulawayo

Constraints of this technology are:

- Challenge of spreading K amongst local institutions

- Building local capacity for repair and maintenance and management of water supply

What water problem might new technology be most appropriate to solve?

- Hot springs
 - How can it be used
- Saline water
 - Knowledge
- Industrial pollution

Economic issues:

What kind of economic change is needed?

- Cost of simple technology are unattainably high
- Cost of eco-san is similar but permanent
- Scientists need to advocate to the govt.
- Local manufacture of systems and parts
- Trade off between long run and short run benefits
- Regulation and compliance
- Provide education and K
- Increase funding for R&D
- Enhance S&T capability - applied research
- New business model
 - Selling sanitation needs encouragement.

The conclusion reached at the end of this discussion was that, "there is no real water quality issue that cannot be solved with existing technologies".

This was an interesting stage in the dialogue to introduce the idea of nanotechnologies applied to water filtering.



Jack Stilgoe introduces Nanotechnology

A brief introduction to nanotechnologies was given, including reference to the Royal Society (2003) Report and the concept of the nano-divide that it contains. Some application areas were covered in terms of the likely impact on developing countries and reference was made to the work of the Toronto team (Salamanca-Buentello *et al* 2005). For developing countries the Toronto team suggests that the top three applications of nanotechnology that is most likely to have an impact are: energy, agricultural productivity, and water filtration.

Asked for general thoughts and feedback on nanotechnology, first from the scientists and second from the communities.

Scientists views:

- How applicable are these new technologies to the developing world? Will it not be a higher cost? [yet the hype suggests that it is cheaper]. Costs of applications are likely to be too expensive for developing countries.
- What will the reality look like? It appears to be a long way off from our point of view.
- Will we have the skills to use this technology?
- What will be the impact on the environment? On crops, land etc. Based on historical perspective of mining extraction etc earlier in

Zimbabwe then pollution was a key issue.

- What about existing technologies? Are they not already able to solve our problems?
- How available will this technology be? Maybe some skill shortages.
- Fear of the unknown - mostly among users.

Community views:

- How can we access this technology given our resource base?
- Who will benefit from this technology?
- Would like a demonstration that it works to allay fears.
- Would it be suitable for humans, animals, etc?
- Will it be sustainable?
- Just talking with the communities implies that there is a solution coming. But we are tired of this because no solution comes. Expectations are raised when we start dialoguing.
- Lack of knowledge of the time cycle is critical. How long will it take before solutions come?
- Need clear articulation of objectives.
- People are suspicious of clear water with no smell. This is different from what has been known traditionally.
- Effective communication in the Shona language is needed.

Given the general level of scepticism in the feedback from the communities they were probed with the question: "What would make you feel there was more trust?"

- We live in hope that our expectations will be met.
- Why talk to us if you are not offering us something.

- We expect clean potable water. We do not know when.
- Full consultation process - follow through.

So that the discussion could continue with a focus on what might be practical, we introduced the case study of South Africa (Hille 2006). A number of questions arose during this discussion that we felt unable to answer. These were:

- Could the pollutants be removed with other technologies?
- What are the economics of nano-membranes compared to other technologies?
- How might the technology be manufactured locally?
- If you had US\$21,000 to spend (the cost quoted in the case study) on what alternative technology would you spend it?
- Could a Zimbabwean Institution adapt or adopt the technology used in the case?
- How easy is the maintenance of the system?

A number of ways forward were discussed and the following noted as action points:

- Talk to North Western University in South Africa.
- Southern African Development Corporation might develop a protocol.
- International collaboration could be the way forward.
- WaterNet might be used as a Southern African research network.

Towards Consensus on the Critical Issues

In an effort to draw together the many strands of conversation that occurred in the workshop we posed the following question: "What three issues stand out as being critical to the adoption/adaptation of new water-related new technologies?"

Each participant was given three cards and asked to write an issue on each card. The cards were then collected and posted on the board (A list of issues can be found in Table 2).

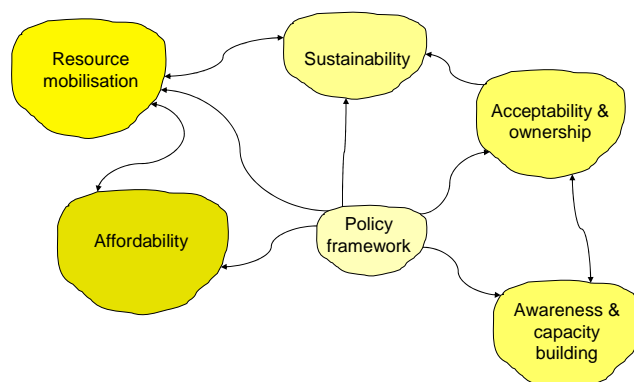
These issues were then grouped into six clusters. Each person was given 3 votes, which were assigned as follows:

- Resource mobilisation for R&D - 12
- Affordability (cost) - 16
- Sustainability - 7
- Acceptability and ownership - 9
- Awareness and Capacity building - 9
- Policy framework - 1
- There is no water quality issue that current technology cannot solve - 0

Total votes = 54 (18 people)

Figure 8 shows these critical issues in diagrammatic form where each issue is sized in proportion to the number of votes received. Lines have been drawn to show the relationships between each issue. This shows that although policy framework received only one vote, it is central to the resolution of the other issues.

Figure 8 Critical Issues



Local Context: Epworth Community

On 19 July the Practical Action team of organisers met with the Epworth community to visit their water supplies with the aim of increasing understanding of the local context. We saw three types of water supply: a spring, a shallow well with bucket and rope, and a deeper well in the process of being dug. Together these sources supply the water needs of around 5,000 people many of whom have to walk considerable distances several times per day. The following photographs illustrate these features.

Rope and Bucket Water Source



Spring Water Source



Borehole Water Source



Day 3

The day began with an introduction of purpose and a brief recap. Three additional people were introduced as observers from Practical Action. Lawrence translated into Shona some of the key ideas so that the two local communities were fully briefed.

The facilitators recapped on the process and content that had been covered in the first two days of the workshop.

The main part of the day began with the question: "What questions are outstanding for the scientists?"

The purpose here was to agree those questions that could not be answered by the scientists who were present at the workshop. These issues would then be taken to nanotechnology experts, such as Mark Welland, to gain additional views from Northern scientists.

Six questions had been captured in the earlier part of the workshop. These were recalled and scientists were asked to add additional questions.

- How applicable are these new technologies to the developing world? Will it not be a higher cost? [yet the hype suggests that it is cheaper]. Costs of applications are likely to be too expensive for developing countries.

- What will the reality look like? It appears to be a long way off from our point of view.
 - Will we have the skills to use this technology?
 - Could the pollutants be removed with other technologies?
 - What are the economics of nano-membranes compared to other technologies?
 - How might the technology be manufactured locally?
 - What will be the impact on the environment?
 - Will we see the benefits by 2015?
 - What will the economic benefits be - jobs, livelihoods?
 - How might the technology be tailored to local needs?
- How quickly can the technology be diffused?
 - How can nanotechnology add value to existing water technology?
 - How applicable are these nanotechnologies at the small (local) scale?
 - How durable are nanotechnologies in terms of lifespan (of product and maintenance)?
- At the end of day 2 we had defined a number of critical issues. To make recommendations on the critical issues we considered the following two questions:
1. What behavioural changes are needed?
 2. What economic changes are needed?
- These were captured on a flipchart and reproduced in Figure 9.

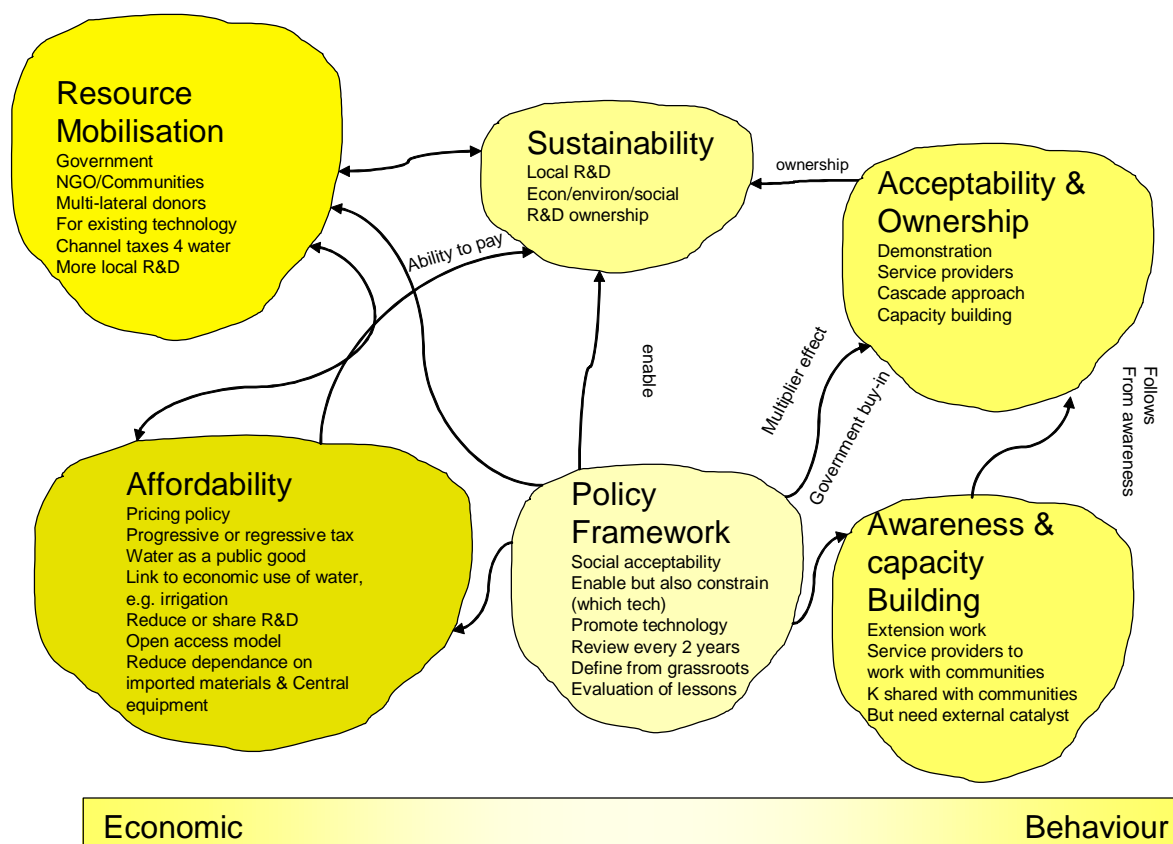


Figure 9 Critical Issues in Terms of Economic and Behaviour Changes

What sort of new technologies would you like to see in the future?

Desirable technologies are those that meet the local needs that we have been discussing in the dialogue.

What sort of research needs to be done?

- Locally in Zim to research into alternatives to make things cheaper and locally manufactured. About local adaptation using local materials for example.
- Also to do the above rather than wait for outside solutions.
- Impartial research into the risks as well as the opportunities.
- A user driven research agenda
- Research the problems that communities face to increase knowledge and understanding.
- Need for water research to deliver clean water at the household level.
- Alleviating poverty as the outcome of the research.
-

What should scientists do?

- *in Zimbabwe*
- More funding for research in the country.
- Public and private finance
- Culture of research in local institutions needs building.
- Equipment and money is needed
- Access to Internet means that knowledge is more available except for some journals.
- Have civil society input to science agenda.
- Need collaboration with other countries.
 - o New ideas
- *in UK*
- Collaborate when there is "a story to tell"
 - o Put the end user into the research agenda.
 - o Collaborate after the agenda is defined.
 - o Agenda to be defined by need.

- Does this mean there is a danger in collaborating too early?
 - Risks of collaborating too early
 - Could a common research agenda be defined?
 - o Create a platform
- UK should lead research so long as it is driven by need.
Make research knowledge applicable to developing countries

Other scientists should collaborate and create trust in the people. There needs to be consultation before products are developed.

Collaboration with scientists outside Zimbabwe

At Institutional level North to South

In the afternoon we discussed "water as a public good" - was this supported and how would it be paid for? The point was made that someone would have to pay. But most people in Zimbabwe could not afford to pay for it.

Table 1 Community and Scientists Responses Compared

Questions	Communities	Scientists
In what areas of your life would you benefit from new water related technology?	<ul style="list-style-type: none"> ▪ Rainfall affected from roof and from storage containers. ▪ Open wells and springs are not protected - pollution from animals. ▪ Children and animals drink water from dams 	<ul style="list-style-type: none"> ▪ Cost of new technologies ▪ Lack of resources ▪ Poor introduction of the technologies - possibly dumped on people. ▪ Resistance to change ▪ Cultural norms
What do you see as hindrance to society's uptake of new water-related technologies?	<ul style="list-style-type: none"> ▪ Access to technologies ▪ Access to financial resources ▪ Access to materials ▪ Lack of knowledge ▪ Customs in relation to springs ▪ Attitude and behaviour patterns. 	<ul style="list-style-type: none"> ▪ Involvement of the community throughout the process ▪ Community empowerment ▪ Communities to identify their needs and come up with projects - demand driven ▪ Engage in open discussions ▪ Public awareness
What do you consider to be your role in quickening the uptake of new technologies?	<ul style="list-style-type: none"> ▪ Develop knowledge base and share with the community ▪ Develop knowledge based structures ▪ Organise and lobby for funds ▪ Empower communities with a sense of joint ownership. 	<ul style="list-style-type: none"> ▪ Involvement in public dialogue ▪ Public demonstrations ▪ Extensions of knowledge ▪ Engage communities throughout
Which water related technologies have you found to be beneficial to your community?	<ul style="list-style-type: none"> ▪ Piped water ▪ Deep wells ▪ Water divining ▪ Treatment with chemicals 	<ul style="list-style-type: none"> ▪ Rope and washer pump ▪ Treadle pump ▪ Sand abstraction systems ▪ Cheap domestic water filter ▪ Eco-san - to protect the water sources ▪ Clean production systems

Table 2 Top Three Issues

- Access to funds
- Education and training on nanotechnology (2)
- Money needed (4)
- Knowledge sharing and dissemination (2)
- Can the communities afford new technologies?
- How can it be sustainable? (4)
- Acceptability - will communities accept new idea? (4)
- Demonstration widely
- Linking research institutes with others outside
- Resource mobilisation for advocacy
- Work together with the community
- Share ideas with the community
- Need to build S&T capacity
- Need for local manufacturing of water technologies
- Policy framework
- There is no water quality issue that cannot be solved with existing technology
- Lack of skills
- Insufficient knowledge
- Cost structure
- Applicability
- Availability of research funds
- Cost of implementation of new technology
- Need alternatives
- Cost of technology and maintenance
- Ownership
- Patenting technology
- Participation

- Availability of resources - financial and materials
- Impact on the environment
- Dialogue
- Awareness
- Easy to operate in the community

These were grouped into the following:

- Cost
- Awareness
- Acceptance
- Sustainability
- Skills and capacity development
- Policy framework
- Resource mobilisation
- Availability of alternatives

Afterwards tried to add labels to each cluster of issues.

Each person was given 3 votes, the results are shown below:

- Resource mobilisation for R&D - 12
- Affordability (cost) - 16
- Sustainability - 7
- Acceptability and ownership - 9
- Awareness and Capacity building - 9
- Policy framework - 1
- There is no water quality issue that current technology cannot solve - 0

Total votes = 54 (18 people)

Table 3 Summary of Recommendations

Issue	Recommendation	By who
Affordability	Build resource capacity within communities Adopt open access model which allows for local material use Implement a means-tested water subsidy system.	NGO, LA's, Ministries inc: Min of SME's, Min of Ag. Min. of S&T, Min of Water Local scientists, Institute of Water and Sanitation Government
Resource mobility	Build resource capacity within communities Empowerment of communities to manage their resources Give priority to local R&D on water. Collaborating with other countries	NGO, LA's, Ministries inc: Min of SME's, Min of Ag. Min. of S&T, Min of Water Min of Natural Resources, LA's Min of Finance
Awareness	Service providers to work with communities. Share knowledge about technologies with communities to educate and open dialogue by using focus groups.	Communities, local authorities, scientists, Government, NGO's.
Acceptability	Demonstrate the capabilities of new technologies to improve water quality and provide extension services. Full participation of communities at various stages of the project. Service providers to work with communities.	Scientists, local authorities, NGO's, Government. Communities, local authorities, scientists, Government, NGO's
Sustainability	Promote local R&D and local ownership. Solutions must be technologically, socially, and environmentally sustainable. Develop/build economic and technical capacity to maintain the technology.	Scientists, multilateral agencies, NGO's
Policy framework	Give tax incentives for public/private partnerships for water related projects. Review technology lessons every 2 years. Evaluate S&T policy at regular intervals.	Government, Government Government, scientists, communities and other relevant stakeholders

Conclusion

The provision of clean water to both rural and peri-urban communities in Zimbabwe is complex. The systems approach to the analysis and reflection on the topics discussed in the dialogues has enabled a comprehensive capture of the complexity and inter-related issues in relation to the presenting problem.

The modelling of the problem situation was particularly helpful in articulating the sub-systems needing discussion. The dialogue was able to focus on the three sub-systems of water supply, culture, and technology. Further, we were able to focus on both economic and behavioural changes required.

The multiple stakeholder approach to the dialogue worked well with all those involved being able and willing to participate fully.

At the end of the second day the tentative conclusion that: "there is no real water quality issue that cannot be solved with existing technologies" was agreed but this was not the consensus at the end of the three days.

There are a number of outstanding issues that the workshop could not resolve. These include:

- Questions for scientists to answer - summarised on page 10.
- Whether existing or new technologies were needed to solve the presenting problem.

The overall recommendations of the workshop are outlined in Table 3 which shows the recommendation in relation to the critical issues identified and states who needs to be responsible for implementation.

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Appendix 1 List of Stakeholder Participants

	Name of Participant	Organisation	15	16	22
	Academics/Researchers/Scientists				
1	Sibekile Mtetwa	Zimbabwe National Water Authority	✓	✓	✓
2	Herold Sibanda	Water and Sanitation Development	✓	✓	✓
3	Crispen Mutsvangwa	National University of Science & Technology	✓	✓	✓
4	Cleophas Musara	Mvuramanzi Trust	✓	✓	✓
5	Amatus Rwazemba	Mvuramanzi Trust	✓	✓	✓
6	Sthabile Tirivarombo	Chinhoyi University of Technology	✓	✓	✓
7	David Love	WaterNet	✓	x	x
	Rural Community				
8	Gift Matembudze	Chakohwa Community	✓	✓	✓
9	Talkmore Mukundu	Chakohwa Community	✓	✓	✓
10	Rosemary Muchini	Chakohwa Community	✓	✓	✓
	Peri-Urban Community				
11	Grace Bwanya	Epworth Community	✓	✓	✓
12	Tsitsi Mafuta	Epworth Community	✓	✓	✓
13	Zhuwawo Mugwagwa	Epworth Community	✓	✓	✓
	Organisers				
14	David Grimshaw	Practical Action	✓	✓	✓
15	Lawrence Gudza	Practical Action	✓	✓	✓
16	Robert Ngara	Practical Action	✓	✓	✓
17	Jack Stilgoe	Demos	✓	✓	✓
	Facilitators				
18	Barry Chinwadzimba	Zimbabwe Occupational Standards Services (ZOSS)	✓	✓	✓
19	Eric Hamadziripi	Zimbabwe Occupational Standards Services (ZOSS)	✓	✓	✓
	Video Filming				
20	Ashwin Sikireta	Video-Net	✓	-	✓
	Practical Action attendees				
21	Ernest Mupunga	Practical Action	✓	✓	
22	Sylvia Makomva	Practical Action	✓	x	
23	Thembinkosi Nyathi	Practical Action	✓	x	
24	Tinashe Nhete	Practical Action		✓	
25	Cephas Munjeri	Practical Action		✓	
26	Anne Callum	Practical Action (UK) - observer			✓
27	Ramona Miranda	Practical Action (S. Asia) - observer			✓
28	Cecilia Fernandez	Practical Action (LA) - observer			✓

Appendix 2 Opening Speech

Speech by the Honourable Deputy Minister of Science and Technology Development; Mr. Patrick Zhuwawo at the occasion of the Opening of Nanodialogues Workshop at Cresta Lodge at 10.00 hrs. on 15 July 2006.

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- The Regional Director of Practical Action Southern Africa; Mr. Ernest Mupunga
 - Practical Action Southern Africa Programme Team Leaders,
 - Demos Representative Dr Jack Stilgoe
 - Responding to New Technologies International Team Leader, Dr. David Grimshaw,
 - Distinguished guests, Ladies and Gentlemen:

It is my sincere pleasure and privilege to welcome you to the opening of this very important Nanotechnology Dialogues Focusing on Water forum.

I would like to sincerely thank Practical Action Southern Africa with assistance from Demos, for hosting this historic meeting in Zimbabwe - and I understand that it is the first in our region. I urge you to take advantage of this meeting to dialogue and develop well thought out strategies and set priorities that will contribute to Zimbabwe's social and economic development.

Nanotechnology is profoundly impacting on our world today and is internationally acclaimed as having the potential to provide greater efficiency in energy use; help protect the environment by reducing waste and harmful emissions; and to solve major health problems.

Nanoscience and nanotechnology involve studying and working with matter on an ultra-small scale. Nanoscience and Nanotechnology encompass a range of

techniques rather than a single discipline. The technology stretches across the whole spectrum of science, touching medicine, physics, engineering and chemistry.

It is also important to note that nanotechnology and the nanosciences are currently high on the international research agenda, with Governments spending significant amounts of money every year in this growing area of scientific discovery.

Although Zimbabwe and the rest of sub-Saharan Africa have not yet fully embraced this new technological race, it is my sincere hope that this gathering will kick-start the process.

The Government and people of Zimbabwe have acknowledged the important role that science and technology plays in the development of economies and the well being of society. It is in this light that my Ministry was established and through the Research Council of Zimbabwe and other stakeholders, we formulated a Science and Technology Policy within which essential S&T programmes and activities are undertaken.

We also have just completed our Information and Communications Technologies policy framework, a move that will see the adoption of science and its related benefits to society.

This ministry has created the necessary enabling policy environment. Through the said frameworks, active and effective research and development initiatives have been or are being implemented, resulting in the transformation of ideas into economically and socially valuable products.

My Ministry will therefore support all efforts by both the public and private sector in all nanoscience initiatives, as this technology will now usher in a new era of economic growth through enhanced

innovation and increased productivity. Activities in this area will therefore enhance the National Economic Development Priority Programme (NEDPP), a short-term stabilization programme derived from the Government's Vision 2020 that seeks to restore economic stability. Above all, nanoscience initiatives can bring with them healthy livelihoods for our citizens.

Ladies and gentlemen, my ministry realises that we alone cannot develop and implement all the science and technology initiatives, and therefore we have forged strategic alliances with various research and development organisations, locally, regionally and internationally. Practical Action Southern Africa is one of the foremost NGOs we have been closely working with over the years in the area of new and appropriate technologies.

Practical Action works specifically with communities helping them choose and use appropriate technologies to improve their lives for today and for generations to come. To this end, I am aware that rural communities are represented here by the Chakohwa, Chimanimani community, while the urban and peri urban communities are represented by the Epworth community. Both these communities are here as equal partners in the dialogues, and will contribute to the nanoscience agenda.

The efforts by Practical Action Southern Africa with the fully fledged support of my ministry have the potential to strategically place Zimbabwe as one of the key players and pioneers of this dynamic area of science and technology within the region.

It gives me great pleasure to note that such efforts by Practical Action, have heeded to my ministry's call to use science to mitigate poverty and at the same time, improve on livelihoods of our citizens.

Zimbabwe, like the rest of the world cannot afford to ignore the nanotechnology and nanoscience revolution and hope to

succeed in this highly competitive global village.

Ladies and Gentlemen, the area of nanotechnology is a relatively new frontier to Zimbabwe and the Southern African region. The challenge facing my Ministry and various players in this field will be to cultivate a breeding ground for a nanoscience revolution and encourage continuous dialogue for the common good of its advancement.

Dialogues such as this one should therefore help us come up with a well thought out strategies that should strengthen our place in the global considerations on nanotechnologies.

I wish you fruitful deliberations, as I declare the workshop officially opened.

Appendix 3 Timetable of the Stakeholder Workshop

Day One

TIME	ACTIVITY	SESSION CO-ORDINATOR
09.00	Registration	Lawrence/Robert
2 MINS	Welcome; Introducing the Hon. Minister of Science & Technology Dev. Dr. Olivia Muchena	Lawrence
09.45 HRS	Official Opening	Minister of Science & Technology Development; Hon. Dr. Olivia Muchena
3 MINS	Housekeeping; Workshop Objectives: (What we will do, what we want to Achieve)	Lawrence
20 MINS	Self-Introductions, Expectations (and Perceived Contribution)	Facilitators
10 MINS	Nanotechnology and the Nanodialogues: Why we are doing this?	Co presenters Jack and David (Lawrence interpreting in Shona some of the issues)
10 MINS	Problem Definition	David and Jack
3 MINS	Workshop Methodology: Visualised Participatory	Facilitators (Lawrence interpreting in Shona some concepts)
5 MINS	What do we have to do in exploring and identifying Problem?	David and Facilitator
10.30 - 11.00	Tea/Coffee	
2 HRS	Chaired Session: Modelling of Key Issues, Problem Conceptualisation (cont)	Chairperson David (Lawrence interpreting in Shona some concepts)
13.00 - 14.00	Lunch	
1 HR	Modelling of Key Issues, Problem Conceptualisation	Chairperson David (Lawrence interpreting in Shona some concepts)
15.00 - 1530 HRS	Tea/Coffee	
30 MINS	Cohesion: Summary of Problem Characteristics/ Features/ Dimensions	Facilitator (Lawrence interpreting in Shona some concepts)
EVENING	Get to know each other refreshments	Lawrence

Day Two

TIME	ACTIVITY	SESSION CO-ORDINATOR/FACILITATOR
09.00	Recap:	Facilitators
1.5 HR	Chaired Session: Comments/ Views/ Testimonies from scientists - dialogue with the public	Chairperson David (Lawrence interpreting in Shona some concepts)
11.00 - 11.30	Tea/Coffee	
1.5 HR	People's views: Water and Nanotechnologies	Jack (Lawrence interpreting in Shona some concepts)
13.00 - 14.00	Lunch	
1 HR	Consolidation: Views Issues, Ideas, etc.	Facilitators
15:00 - 15:20	Tea/Coffee	
30 MINS	Issues for Consideration: Judgement of Reaction, Alienation, Control, Benefit, Alternatives, Risks, Governance, etc.	Facilitator
20 MINS	Consolidation of Views of the Problem	Facilitator (Lawrence interpreting in Shona some concepts)
10 MINS	What Next? Information on activities for Day Three	Lawrence
16.00 HRS	End of Day Two	

Day Three

TIME	ACTIVITY	SESSION CO-ORDINATOR/FACILITATOR
09.00	Purpose of the day, including outcomes. Recap:	David Facilitators
1.5 HR	Chaired Session: Questions to the Scientists (that we can't answer here) Nano and other technology adaptation. What behavioural changes are needed? What economic changes are needed?	Chairperson David (Lawrence interpreting in Shona some concepts)
11.00 - 11.30 Tea/Coffee		
1.5 HR	What challenges remain for scientists?	Jack (Lawrence interpreting in Shona some concepts)
13.00 - 14.00 Lunch		
1 HR	Recommendations: Bringing things together	Facilitators
15:00 - 15:15 Tea/Coffee		
20 MINS	Recommendations: To who?. Scientists, Government, NGO, researchers, others	Facilitator
15 MINS	What next?	Facilitator (Lawrence interpreting in Shona some concepts)
5 MINS 5 Mins	How can we take things forward? Reflections on the workshop.	Lawrence
16.00 HRS	End of Day Three	

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*“to enable poor women and men to assess and respond to the
challenges of science-led new technologies, and to develop and
adopt applications that improve livelihoods”.*

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