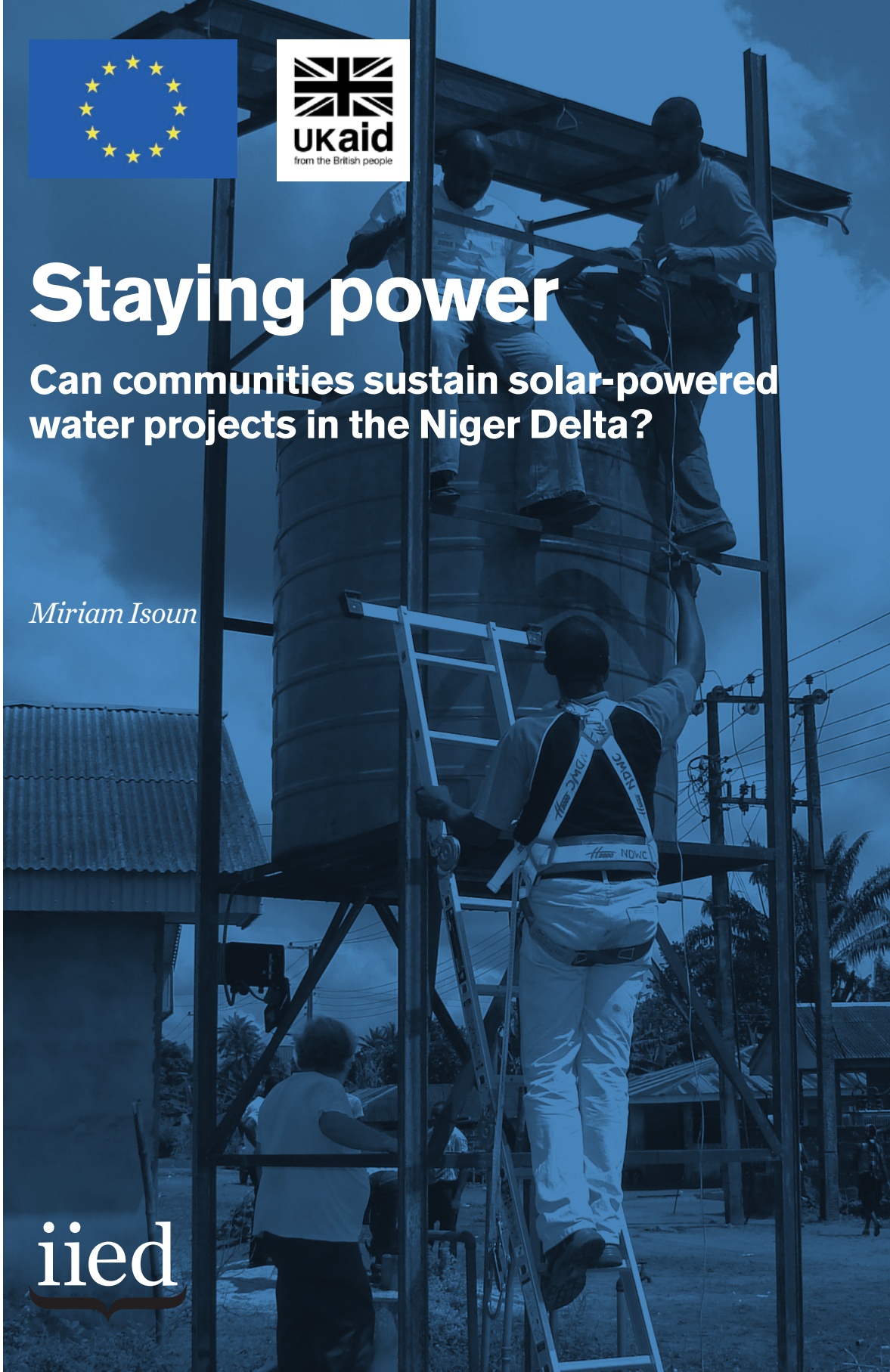


# Staying power

## Can communities sustain solar-powered water projects in the Niger Delta?

*Miriam Isoun*

iied

Access to Energy series
Series Editor Emma Wilson

## About the author

Miriam J Isoun is the founding Executive Director of the Niger Delta Wetlands Centre (NDWC), which was established in 1992. The focus of this NGO has been on improving the quality of life of the people of the Niger delta through natural resource management and biodiversity conservation, and the application of modern science and technology (e.g. renewable energies, biotechnology, ICT) and capacity building. She received a BSc (Hons) and MSc from Michigan State University and a PhD from the University of Ibadan, Nigeria, where she was a lecturer and carried out research in cell and molecular biology until her retirement from academia.

## The SUNGAS project

The SUNGAS project aims to catalyse development of Nigeria's natural gas and renewable energy markets through innovation, demonstration, policy dialogue and advocacy. Small demonstration projects for both renewables and gas-to-power will show that community-based energy facilities are technically viable, financially sustainable, and can ensure better access to modern energy services for rural communities. The project is funded by the European Union and is being implemented by the International Institute for Environment and Development (IIED), the Niger Delta Wetlands Centre (NDWC), the Living Earth Foundation (LEF) and Stakeholder Democracy Network (SDN).

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For further information on the work of the European Union see http://ec.europa.eu/world/.

For further information on the SUNGAS project please contact Emma Wilson (Emma.Wilson@iied.org)

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Cover image: NDWC training: trouble-shooting faulty small solar system in Delta State


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## Abbreviations and Acronyms

| | |
|---|---|
| CDC | Community Development Committee |
| JICA | Japanese Aid Agency |
| LGA | Local Government Area |
| LNG | liquefied natural gas |
| MOSOP | Movement for the Survival of the Ogoni People |
| ND-CSD | Niger Delta Conservation and Sustainable Development programme |
| NDDC | Niger Delta Development Commission |
| NDWC | Niger Delta Wetlands Centre |
| OTI | Office of Transition Initiatives |
| PRA | participatory rural appraisal |
| RET | renewable energy technology |
| RUWASAA | Delta State Rural Water Supply Agency |
| SLA | sustainable livelihood assessment |
| SPDC | Shell Petroleum Development Company |

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# Summary

The remote riverine communities of the Niger Delta inhabit a rich tropical rainforest ecosystem in huge and virtually undocumented wetlands – surrounded by 'water, water, everywhere, but not a drop to drink'. The Delta's abundant surface and groundwater is generally not potable by World Health Organization standards. Deep boreholes provide clean drinking water, but power is not readily available either to pump it to the surface, or to treat contaminated surface water. Connection to the national grid is unlikely for the foreseeable future; generator-powered pumps are polluting and expensive to fuel. While solar energy presents itself as an effective solution to power water pumps – as well as meeting other energy needs of these remote communities – numerous failed solar water projects in the Delta have lent this option the reputation of being unworkable.

Why do so many solar water projects fail? How can they be designed, constructed and sustained to provide the Niger Delta's people with long lasting access to clean drinking water? This paper describes how the Niger Delta Wetlands Centre (NDWC) has tried to find effective ways to provide potable water using solar-powered systems, and to understand and overcome the technical and socio-economic challenges to sustaining them. Among other activities, NDWC has established a renewable energies technology programme; built awareness of solar energy among the public and development professionals; provided training in the design and implementation of solar-powered water systems; and implemented private, grant-funded and agency-contracted solar-powered water systems. The NDWC has also been a key partner in the EU-sponsored project, Sustainable Utilisation of Nigeria's Gas and Renewable Energy Resources or SUNGAS, which is managed by the IIED and focuses on the issue of sustainability in delivering energy access to local communities in the Niger Delta.[1]

## Lessons learned

Having worked with several sponsors in various locations in the Central Niger Delta, the Wetlands Centre feels it can offer a holistic view of the challenges encountered in implementing solar water projects. The lessons learned may help others to bypass some difficulties when planning similar projects, especially in the Niger Delta.

## Technical findings

An NDWC survey of solar powered water projects in Nigeria found that many of the failed projects were installed by sponsors who made no plans for monitoring and evaluation, for design improvements, or for putting accountability systems in place. Communities rarely know how their systems work or who to report problems to. NDWC also found that sponsors provide fixed project designs, and insist that their specifications be followed; yet the technical design is often poor. This predisposes solar water systems to fail, especially overly complex systems such as those with batteries or many kilometres of pipes to distribute water.

NDWC's work produced a wealth of technical lessons. For instance, providing water at a collection point close to the water tank, rather

1 Other project partners include the Living Earth Foundation and Stakeholder Democracy Network. The project website can be found here: www.sungas-nigeria.org.

than to multiple collection points, reduces the need for pipes and hugely increases the chances of the system's success and cost-effectiveness. Other lessons included the optimal depth of boreholes; sourcing durable components for solar water systems; identifying reliable contractors and using local unskilled labour.

## Socio-economic findings

It has been demonstrated that solar-powered water systems are a realistic means of providing potable water in the Niger Delta, even in the smallest villages in the most remote areas. Yet many technically successful projects have failed after commissioning due to a lack of community ability to sustain projects. One root cause of failure can be sponsors' top-down approach, 'giving' energy projects without meaningful interaction with the beneficiary community. It is crucial to understand a project's local context, using a participatory approach to identify people's needs, and to be sensitive to any underlying social conflicts.

One of the greatest challenges faced by the NDWC-SUNGAS team was getting a workable and realistic 'sustainability plan' in place, for communities to take responsibility for their solar-powered water project after the contractors have left the site. Community management groups tended to break down after the system became operational; community members lacked both the time to sit on committees and the money to contribute to maintaining the system. The NDWC-SUNGAS pilots trialled several methods to facilitate communities' management of their own water systems, which form the basis of some of the recommendations below.

## Recommendations

*Technical sustainability*

Where solar water projects were robust and stayed operational – even providing clean water during the 2012 floods, when generator-driven boreholes failed – news spread, and caused a groundswell of interest in this renewable technology. The main keys to a technically successful system are:

- System design should be robust and as simple as possible, with no moving parts except for the pump, and no batteries. Pumps should function automatically without the need for manual operation.
- Communities should know how to report faults, and a system should be in place to correct them immediately.
- The public, contractors (service providers), and artisans should be educated about solar energy, particularly in projects in their area; demonstration projects should be publicised.
- Sponsors should be accountable for the performance of the projects they have undertaken through demonstration of a contract and sponsorship of a management plan following completion of the construction.
- Water systems need adequate protection from accidental damage and vandalism.
- An online database for solar-powered projects should record contractor information (including project outcomes); specifications of projects implemented; and sources for procuring system components, with user evaluations. This could be based in a government agency or NGO.

### *Socio-economic sustainability*

Energy and water systems are essential public services, but in developing countries the poorest cannot afford to pay sufficient 'rates', 'tax' or levies – if they are collected – to cover the costs of these services. Where sponsors provide a water project, there are two ways in which the community can take responsibility to sustain it:

- Chiefs can take personal responsibility to find funds to sustain the project. They can use funds attached to their offices or use their authority to seek outside funds and capacity for maintaining them. Where the responsibility for operation and maintenance of a project has been formally accepted by a government department, the chief and elders will still need to interface between the department responsible and the service delivery.
- Community members. NDWC concludes that it is unrealistic to expect rural communities to manage projects such as power and water systems. Even small systems are too expensive and complex, and require technical expertise and continuous funds that are not available. However, communities should be taught how systems work, how to maintain them and where to get help when required; to prevent and report accidental damage, and report vandals to responsible leaders. This could take place through a water committee, albeit one with a limited remit, in order not to overburden its members. The remit could include supporting leadership in securing funding or technical assistance.

Another option is to operate a water system as a franchise. Responsibility for sustaining the system lies with the franchisee, who charges for water and sets aside a proportion of the takings to pay for maintenance. While reduced demand for drinking water in the wet season makes this option unlikely to be profitable, ways to grow the business – such as price-setting and delivery options – could be investigated.

### *Sponsor and partner relationships with local NGOs*

The trend away from grants and towards contracts, with NGOs as 'service providers', curtails NGOs' ability to grow and be sustained. Recommendations to improve the relationship between sponsors/partners and NGOs during the project period include:

- Return to a system of grants, or a compromise between a grant and business contract tender system.
- Deal with partners on an equal basis; start together from project inception.
- Ensure that the NGO is not overburdened with paperwork and meetings required by partners.
- Respect local knowledge, expertise and experience, and assume that people have integrity.
- Provide an institutional support budget line for discretionary use by NGOs.

# 1
# The Niger Delta: problems and potential

Nigeria's Niger Delta is both nationally and globally significant. Nationally, because the Niger Delta is the source of most of Nigeria's oil and gas, which provide over 90 per cent of Nigeria's export income, and diverse downstream industries that provide goods and services with huge income generating opportunities. And it is globally significant because it has huge and virtually undocumented wetlands, comprised of tropical rainforest ecosystems. Their rich biodiversity[2] has great medicinal, food and commercial value, of international significance; and they provide a vast carbon sink, offsetting global warming and buffering other climate change impacts.

The importance of Niger Delta's wetlands cannot be overestimated; they have been described as being among the most precious resources on Earth (Ezenwaka & Akinsola, 2006). Box 1 summarises a few of their key functions relating directly to local people's quality of life, and particularly to the hydrological services they provide.

The Niger Delta extends about 450 kilometres eastwards from the Benin River estuary and terminates at the mouth of the Imo River. It covers an area of about 70,000 square kilometres, consisting of barrier islands, estuaries, mangrove swamps, creeks and freshwater swamps. The Niger Delta's numerous large rivers, connected by complex river and stream networks, drain into the Atlantic Ocean.

The traditional uses of the renewable natural resources of the forests and waterways of the Niger Delta have supplied virtually all the needs of its people. Transport depends on dug-out canoes made from local trees. This connects communities, markets, subsistence farms and forest wood-gathering sites, where wood is collected for construction, sale and firewood, as well as fresh water. A wide range of timber and non-timber forest products are collected, both aquatic and terrestrial, for food, medicine and implements. The value of these resources and the extent of their use are under-appreciated in economic assessments of land use when planning for natural resource management and development interventions (Isoun, 2006).

The people of the Delta live mainly on or near the riverbanks, as the rivers and forests along them are their only source of transport and livelihoods. They hunt, fish, harvest timber, and gather for sustenance, for income, and for cultural activities. However, exploitation and extraction activities are increasing, driven by population growth and the rising demand for consumer goods. Oil industry activities damage their land, polluting their air and waterways and contributing to the breakdown of social structures. As these trends continue, so their poverty worsens.

Governments focus their development activities on urban areas, which are accessible and have vocal and demanding constituencies; while

2 'The full significance of the Niger Delta's biodiversity remains unknown because new ecological zones and species continue to be uncovered and (even) major groups such as higher plants and birds remain unstudied in large areas' (World Bank, 1995); 'Biodiversity experts consider the Niger Delta a "biological hotspot" with many locally and globally endangered species' (Obot, 2006).

**Box 1. Services provided by wetlands**

- Wetlands support high levels of biological diversity. They are among the richest ecosystems on the planet, providing essential support for both human and non-human life. Coastal wetlands, which include estuaries and mangroves, are among the most productive. Other wetlands also offer sanctuary to a wide variety of plants, invertebrates, fish, amphibians, reptiles and mammals, as well as to millions of both migratory and sedentary water birds.
- Wetlands are of enormous social and economic value in both traditional and contemporary societies. The development of many of the great civilizations was largely based on their access to, and management of, wetland resources.
- Wetlands are an integral part of the hydrological cycle, playing a key role in the provision and maintenance of water quality and quantity – the basis of all life on earth.
- Wetlands hold runoff water after rainfall, buffering against flooding. By storing water in the soil or retaining it on the surface as lake and marsh waters, wetlands reduce the need for expensive, engineered water control structures. Wetland vegetation also plays a role in slowing down the flow of floodwater.
- Wetlands play at least two roles in mitigating the effects of climate change, by physically buffering climate change impacts and as significant storehouses (or sinks) of carbon.
- Underground aquifers store 97 per cent of the world's unfrozen fresh water, and provide drinking water to almost a third of the world's population. Many wetlands help to recharge these aquifers.
- Wetlands provide a variety of other benefits to people in the form of products that can be harvested for human use. These include fruits, fish, shellfish, meat from wildlife, resins, timber, firewood, thatching materials and fodder.
- Plants and soils in wetlands play a significant role in water purification. This can be important in preventing high concentrations of nutrients reaching groundwater supplies or other sources of drinking water.
- Wetland waterways provide a medium for transport – the only means, in many remote areas of the Niger Delta.

Adapted from Ezenwaka and Akinsola, 2006

government and oil companies' development activities in rural and remote riverine areas are sporadic and careless, and therefore ineffective. Recurring social unrest and militancy in these areas reflect people's powerlessness to seek and obtain redress for the fact that they are not benefitting from their country's wealth.

At the root of all these conflicts lie the problems of social equity and natural resource management. The legal system allows over-exploitation of natural resources by government and industry. Litigation measures, development projects and payment of rents, royalties and compensation are inadequate. They exacerbate existing local rivalries between villages, within the local authority structure and between youth and traditional authorities. 'With such varied value judgements, equitable sharing of benefits can become intractable. In such cases, it is the poor and "voiceless" that lose their livelihood while the more affluent capture all the benefits' (Obot, 2006).

This setting must be understood in order to plan the most appropriate development interventions,

and to understand why they so often do not achieve their objectives.

## 1.1 Addressing problems in the Niger Delta

Over the last 20 years (1993–2013) there have been waves of highly publicised funding from government, oil or gas companies, international and national development agencies, and from NGOs on behalf of these agencies, for 'development' in the Niger Delta. The largest waves are generally associated with support for political change, or in response to security challenges. These huge investments give great visibility to the sponsors, but very few effective, sustainable impacts; and in many cases, funds have increased conflicts or have been diverted to non-governmental organisations (NGOs) and communities outside the areas of the intended target beneficiaries. We in the core Niger Delta have felt especially marginalised as we watch international and local NGOs in the major cities garner huge funds in the name of the Niger Delta, only to spend them on workshops, conferences and appraisals; we do not see follow-up with funds to implement seriously planned, site-specific projects for effective sustainability in the Delta. Such NGOs do not really want to 'get their feet wet' in the swamps!

One way to ensure that funds intended for development and training in the central Delta actually reach the Delta, and are used as intended, is to have a healthy 'indigene-based' NGO system. NGOs from Bayelsa State understand the problems of the area, know the people, and have a vested interest in combatting poverty in remote areas. They should be able to partner with outside agencies and NGOs from a position of strength, and insist on transparency in the use of funds given in the name of the Niger Delta. This was the key conviction that led to the founding, in 1992, of the Niger Delta Wetlands Centre (NDWC) in Bayelsa State. It was founded by a group of highly respected academics and civil servants with decades of relevant experience from living and studying in the Niger Delta.

## 1.2 The Niger Delta Wetlands Centre's approach to development

The Niger Delta is acknowledged by scientists and economists to be rich in renewable and non-renewable resources. These resources are increasingly exploited, ad hoc and without constraint, by key stakeholders from within and outside the Delta. Yet there has been little concerted effort to manage them in sustainable ways, with and for the people who rely on them for their livelihoods, to meet the challenges of climate change and to ensure that they are studied and documented for their potential value to humanity. The founders of the Niger Delta Wetlands Centre had a personal and professional interest in seeing that this situation changes, and wanted to make a contribution to that change. The NDWC's initial activities focused on assisting communities to manage their renewable bio-resources – the basis of their sustainable livelihoods – through research and managed conservation of biodiversity and ecosystems.[3]

A well-known paradigm shift towards 'participatory development' took place in the 1980s in response to the 'green revolution' and top-down development programmes of governments and financial institutions around the world. The focus changed to beneficiaries playing key roles in development decision-making and implementation. A grassroots approach to development, requiring longer periods to implement, was not the forte of large corporations and agencies with development programmes, but was enthusiastically embraced by local non-governmental organisations. NGOs

3 Major research and participatory conservation activities were carried out by NDWC and in partnerships with other organisations; they include the Akassa Project/ProNatura, NLNG/Finima Nature Park, Biodiversity Survey for Brass LNG, and South-South Biodiversity for the Nigerian Natural Medicine Development Agency (NNMDA).

around the world were proving to be effective in facilitating and guiding communities to benefit from development funding; building awareness of their rights; and offering new approaches to solving economic and social challenges.

Until the early 1990s, there were few NGOs in Nigeria to provide such an interface between funding and development bodies and the intended beneficiaries of their programmes, who were generally disempowered. But with the shift to participatory development (influenced by the work of IIED among others), NGO registration in Nigeria soon flourished. The most popular NGO objectives related to human rights, health interventions, agriculture, conservation and resource protection, and microcredit.

From 1993, the Niger Delta Wetlands Centre staff applied their skills and knowledge to the challenges of participatory sustainable development in the Delta. NDWC worked both independently and with other NGOs in the area, such as Pro-Natura International (PNI) in Akassa, and Environmental Rights Action (ERA). NDWC staff attended a plethora of development workshops, which at the time were sponsored by UN organisations, funding agencies and oil companies to prepare for the transfer from military to civilian rule. NDWC spent several years experiencing development projects in action through participation in projects run by the oil company Chevron in their Global Memorandum of Understanding (GMOU) programme, the MacArthur Niger Delta Conservation and Sustainable Development programme (ND-CSD), the Niger Delta Environmental Survey (NDES) sponsored by the Shell Petroleum Development Company (SPDC), the Nigeria Natural Medicine Development Agency's (NNMDA) biodiversity surveys, the Brass Liquefied Natural Gas (LNG) Biodiversity Survey and the World Bank's Coastal Zone Management in the Niger Delta.

These projects carried out participatory assessments (sustainable livelihoods assessments and needs assessments for development planning) and facilitated community-based natural resource management through conservation programmes and by cataloguing resources and their services. The assessments also identified clearly what actions or interventions local people thought held the most promise for improving their quality of life and for securing their children's futures. Not surprisingly, people's prioritisation of needs was similar throughout the central Niger Delta. Health and education topped their lists. Water followed, then microcredit for improving fishing, farming and trade. Energy was not often mentioned as a priority per se, but is obviously an essential element for solving the other problems. For instance, power is needed to pump water from the ground or to treat contaminated water from the surface.

The old means of addressing communities' needs were not working: failed projects to supply energy or water, for instance, were virtually the norm, and communities were sceptical of promises. Villages had seen numerous development surveys; indeed they were tired of being interviewed, surveyed and left, or being given projects they didn't want, or wanted but couldn't manage, or that never worked in the first place. These projects were replicated over and over by incompetent contractors and irresponsible sponsors with no plan for monitoring and evaluation, design improvements or for putting accountability systems in place. It was not uncommon by the end of the 1990s to visit a village with multiple skeletons of water systems or rusty generators or fish-drying ovens left in packing crates – clearly and visibly labelled by the primary sponsors. This situation made for a very difficult working environment for NGOs. It was clear to NDWC that for development to be meaningful, things must be done differently.

## 1.3 'Doing things differently'

From 1999, NDWC has operated out of its conference and residential centre in Yenagoa (Bayelsa State, Central Niger Delta) to provide facilities for other NGOs to operate from, and for NDWC to carry out its training and outreaches to rural areas. This involves using participatory development principles to pilot projects for 'doing things differently', using information technology, renewable energy, and biotechnology,[4] among others. While we did some cautious pilot interventions in all three areas, we found the use of solar energy particularly compelling, as it could contribute to improvements in applications of all three technologies.

If we must have power to enable development, we want the most healthy, sustainable and cost-effective power possible. There is ample evidence that conventional fossil fuel solutions, such as generators, have failed to a great extent in all these respects. And even if access to grid power improves for urban and semi-urban areas, it is unlikely to be widely available in the remote riverine and rural areas of the Niger Delta in the foreseeable future. Thus NDWC decided to look at how solar energy applications could be used to solve people's identified development priorities.

We saw solar power as ideal to provide communication (powering a radio); information and communication technology (ICT) systems, to improve good governance and education; home lighting; and most importantly, potable water, to improve health and reduce the drudgery of carrying water by children and women. This publication is the story of how NDWC has tried to find ways to provide potable water using solar-powered water systems and to understand the challenges to sustaining these systems in the Niger Delta. It is our hope that what we have learned may inform the decisions of others who wish to do the same.

4 Using selected local biodiversity to produce improved cultivars of plants and breeds of animals for improved production in managed local environments.

# 2
# NDWC's solar-powered water projects

## 2.1 Introduction

All participatory research and livelihoods assessments in the central Niger Delta have shown that in spite of the diverse and huge water resources available and used for a wide range of human activities, accessing *potable* water is a major problem for people in the area. This is because of the importance of potable water to health, its scarcity, and the challenging logistics of getting it to where it is to be used.

As a part of NDWC's concern for providing energy in rural areas, a major focus of its development projects became the use of renewable energy, particularly solar energy, for powering water pumps to deliver potable water. This section describes the NDWC's work to assess the challenges and demonstrate the use of solar energy for provision of potable water in the rural Niger Delta.

## 2.2 Assessing and demonstrating solar power

Water availability is not a problem. Throughout the Niger Delta, there is a high water table for ground water, plentiful rainwater, and river water in abundance: assets to be envied in many parts of the world. However, there is little – if any – readily available potable water. A few people use rainwater catchment for some months of the year; in some areas, shallow wells of three to four metres provide water of dubious quality. A few places have had manual pumps but these are not always good quality, and they break down and are not repaired. We wondered what could be done to help.

In 1999, with a very small grant from USAID, we carried out interviews, studied reports and made field observations of water systems in the Niger Delta, to find out what had been done in the past – and what had been proposed but not done. This allowed us to make recommendations to improve the availability of potable water in the Delta. It was found that solar-powered pumps had been considered, but where they were tried their use had not been sustained. The ready acceptance of these failures led to the strongly held widespread belief that solar energy systems are too expensive and too complex to be managed in local settings and that there is not enough sun in the Niger Delta to make them efficient.

However, prices of solar components were coming down and awareness of the potential of solar energy for sustainable projects was increasing, albeit slowly. We believed there was an ideal synergy to be exploited between the need for potable water and the availability of solar energy to pump it. We believed a concerted effort was needed to optimise solar technology applications and their management in our Niger Delta setting. How we carried out this work is set out in this report. It includes: capacity building in solar energy technologies at the Wetlands Centre; constructing solar-powered water projects for the Niger Delta Development Commission (NDDC); constructing a solar water project for the Shell Petroleum Development Company (SPDC); the EU-sponsored SUNGAS project, focusing on making energy projects sustainable; and drawing conclusions and recommendations from what we had learnt.

## 2.3 Review of potable water systems in the Niger Delta in 2000

In 1998, USAID gave numerous small grants of US$5000 to NGOs in the Niger Delta under the Office of Transition Initiatives (OTI). These were given for targeted networking in the NGOs' areas of interest, in anticipation of the transition from military to civilian rule in Nigeria. Niger Delta Wetlands Centre was given a USAID grant of this type in 1999 and carried out a literature review on hydrogeology, surface and ground water exploitation, including Niger Delta Basin Development Authority archives and university publications. The review included past approaches to the provision of potable water in the Niger Delta. This was to form a basis for recommending technical and managerial strategies to provide potable water for local rural people.

### *2.3.1 Water availability*

The Niger Delta is fortunate in that there is easily accessible ground water, efficiently recharged both by underground routes and by filtering through the surface. The Delta has extensive ground water aquifers at depths of 3 to 30 metres and more. It also has ample surface water in rivers, lakes and streams. Nevertheless, in most parts of the Delta, women and children spend many hours of the day carrying water by hand or by canoe, or collecting it from rivers and streams, for drinking and other domestic uses.

The main problems are that the surface water and shallow well aquifers generally have biological contaminants, and water from wells is often contaminated with iron (locally described as 'Fanta water') or other particulates. The situation is a veritable case of 'water, water everywhere, but not a drop to drink'. Potable water that is free of biological contaminants, iron, other particulates and dissolved minerals may be found at greater depths, but these levels are various and unpredictable; they could be from 45 metres to 135 metres and more. Wells must be usually deeper than 245 metres to extract clean water. Drilling for potable water beyond 75 metres is expensive, especially when drilling rigs must be carried by barge to remote riverine villages with steep river banks, and complicated by the tendency of sand and clay to collapse as pipes are inserted in boreholes. Chemicals to stabilise the walls of the well can be wasted and pipes lost, and wells are commonly drilled again and again.

And, of course, a source of power is needed to pump water in boreholes to the surface. Methods used have included manual pumps, which on the whole are unacceptable locally; diesel and petrol generators, which have high recurrent costs and create pollution; and in a few notable cases, solar energy, which has high initial costs. All of these delivery services introduce significant costs and make water systems difficult to maintain.

### *2.3.2 Global trends: energy for islands and remote areas*

During our review, our interest in solar energy led us to investigate current trends in renewable energy for development, especially in island communities around the world where grid-based power is not practical. We were particularly interested in energy for lighting, small household electrical items, communication, heating and pumping water.

We discovered that in countries including Canada, Australia, Indonesia, and Sweden, governments have resorted to solar energy for delivering power to remote and island communities. They found that the huge costs of extending grid power to these areas was impractical because of local people's low demands for power. This is also true of Africa. Ask the remote rural dweller what he wants power for, and he will invariably mention light, radio or television, a fan, in some cases a refrigerator, and little else. For the remote and rural poor who have low power demands, solar is more practical and effective than grid or generator solutions. In these locations, it may however be practical for the small-scale

entrepreneur to buy a small generator for his grinding machine, or to cool drinks for sale. Likewise, visitors from the cities who come to the village for celebrations might choose to have a generator and carry their own fuel for a few days of personal use.

### *2.3.3 Key recommendations for accessing potable water*

Based on the available data, the NDWC recommended two key strategies for accessing potable water in its 2000 report to USAID/OTI.

1. Dig deep wells to avoid the need for treating contaminated water found in shallow wells.
2. Adopt solar energy to pump ground water from wells with potable water.

While it was not OTI's mandate to give funds for development (such as potable water projects), they did follow up our brief report with a grant of US$50,000 for capacity building at NDWC. We used this to complete our first permanent building in Ekeki, Yenagoa, enabling us to move our base of operations from Rivers State to the newly created Bayelsa State. From here we hoped to apply our experience and development networks to developing successful solar-powered water systems.

## 2.4 Capacity building in solar energy technology at NDWC

### *2.4.1 In-house practical training in solar technology systems*

Although we were armed with significant knowledge – both of the challenges of the Niger Delta's hydrogeology, and global trends in applying solar energy to solve these problems – our technical capacity in solar energy applications was nil. In the year 2000 there was still very little technical capacity anywhere in Nigeria for designing, constructing, assembling, managing and maintaining solar energy systems; furthermore, the systems' 'economics of sustainability', or the cost to communities to maintain and repair them, were not understood.

If NDWC were to offer solar energy systems to power development activities in remote areas of the Niger Delta, where grid and generator power were impractical, it must build in-house capacity for solar technologies. We knew there would be challenges specific to our target areas that would need to be considered when designing systems, as well as constructing and managing them. If we had in-house expertise and knew the 'ins and outs' of solar technology, NDWC could minimise the costs of pilot and demonstration projects, reducing costs for development programme sponsors. We could advise on the best use of solar energy where it could be effective and robust and could be monitored and managed by local people, given simple training and instructions. We have therefore made it part of our mission to build awareness of the effectiveness of solar technology for remote communities' essential energy requirements among government and civil society; and to train technicians with skills to design, construct and maintain solar systems in the central Niger Delta. We decided to target those who are most likely to stay in the area once their skills have been facilitated by our NGO.

In 2001, we funded a volunteer, Ernest 'Woody' Thompson, from Canada to come and start up our solar energy activities. Woody had experience in building solar and wind systems in remote areas of Nova Scotia, and we had sponsored him to make a brief visit to UniSolar in Michigan, where he was exposed to the latest in small-scale solar systems for remote areas. He also met others who had worked in Africa. Woody arrived at NDWC's facilities in Yenagoa, and while awaiting the arrival of our order from the USA of high quality equipment (deep cycle batteries, solar panels, charge controllers, DC lights and fan), he worked with NDWC staff and village experts to construct a locally typical thatch-roofed mud and bamboo hut (*akain wari*) for use in the training programme. He then delivered a training course he had designed, which included theoretical material but was 80 per cent hands-on project implementation.

Akain wari, with solar system for lights, laptop, printer and ceiling fan © NDWC

Two courses were offered. The first course was offered to eight unemployed graduates who had no previous knowledge of solar systems; in the second course individuals included local electricians, and unskilled but interested people to serve as informed advocates for solar energy systems. Trainees were taught the principles of using tools wisely, basic electrical wiring and circuits, and the use of solar system components. They were given technical skills in assembling solar systems, and in managing and troubleshooting them. As part of the course they installed a small UniSolar lighting system, a small home electrical system in the *akain wari* (two light points, an overhead fan, a laptop computer and a printer) and a small solar-powered water pumping system.

During the capacity-building activities, we were fortunate to have the opportunity to carry out two small externally funded solar-powered water projects: a private system near Yenagoa, and a grant-supported community system in the creeks of southern Bayelsa State. Brief descriptions follow.

## 2.5 A private solar-powered water system in Tombia

While gathering data about water systems for the OTI study, we had visited Chief Otobotekere, the Paramount Ruler of Tombia-Ekpetiama. He was one of the first Nigerian senior staff at Shell Petroleum Development Company (SPDC), and since his retirement has provided progressive leadership of his people in the areas of environmental management and development.

During our discussions he became interested in our proposed use of solar energy for pumping water. He explained that he had a generator-powered water system (with a 12-metre borehole) that served his residence, staff and


NDWC training: trouble-shooting faulty large system in Delta State © NDWC

NDWC training: trouble-shooting faulty small system in Delta State © NDWC

students of the small private primary school in his compound.

We allowed him to purchase a Sureflo pump and panels that had been imported for our solar technician training, and we installed them for free as a pilot demonstration in February 2003. Within a month of installation, the pump was stolen. (It was likely to have been destroyed subsequently, as this DC pump would not have worked with any of the AC generator systems in the area). A new pump was installed by NDWC in March and an iron bar protector frame was embedded in a concrete foundation over the well to prevent further theft.

At one point water was leaking and the pump not working and a local plumber was called in who was not familiar with solar systems; he replaced the DC pump and plumbing with an AC pump and alternative distribution plumbing. NDWC then put the system back in order with a new DC pump, and did not charge the Chief for labour and small items, but only for the pump.

### *2.5.1 Outcome and future sustainability*

Following increased use of the water system three years later, in 2006, the water table dropped below the level of the pump and the pump 'seized up'. The Chief purchased another pump, which we installed during the rainy season when the water table was high again – but we advised establishing a new and deeper borehole. A new 40-metre borehole that delivered clear water was dug in 2008 at the Chief's expense and the pump from the old borehole transferred to it.

By May 2013, the system was still working well and was providing water to the Chief's home, teachers' quarters, and shared latrines for staff and students. This system will be sustained as long as the owner enforces good management practices and can afford to make the necessary inputs for minor maintenance and repairs.

Private solar water tower in Tombia © NDWC

## 2.6 A solar-powered water system in Gbanraun, Southern Ijaw

### *2.6.1 Setting*

The red colobus monkey, a threatened primate which is endemic to the Western part of the Niger Delta, has attracted the attention of our biologists and the concern of the international conservation community since the early 1990s. Conservation organisations and students had tried to establish support for its protection among local communities. There was some interest, but local people are cynical. They have seen their fish stocks, wildlife and timber depleted rapidly by people from as far away as Ghana, and their air and rainwater polluted by a major multinational oil company across the river. This company spews out polluting gases

**Box 2. Components of a solar-powered water system**

**Battery bank** Used in some solar water systems to store electricity generated during the day in order to power the pump at night.

**Borehole** Drilled to access groundwater. In the Niger Delta potable water is found at variable and unpredictable depths, ranging from less than 45 to 250 metres.

**Charge controller or control box** The charge controller regulates the voltage and current flowing from the solar array to the pump, preventing damage from overcharging. In a system that has batteries, the charge controller prevents the batteries from being overcharged.

**Collecting or fetching point** The site where users collect water. This is usually equipped with two or more taps.

**Float valve or float switch** Like the float valve in a flush toilet cistern, this triggers the pump to turn on and off automatically when water in the tank reaches below or above certain levels.

**Girders and stanchions** Girders are used to construct the tower that supports the water tank; stanchions are the upright supports.

**Inverter** Converts the direct current (DC) generated by a photovoltaic panel into an alternating current (AC) that it can feed into a local electric network or device. However, solar pumps are typically DC, so that no inverter is needed to power them.

**Platform** The tank is mounted on a platform, with enough space around the tank for workers to carry out maintenance.

**Pump** Solar water systems use a DC pump which is submersed in the borehole and delivers water to the tank. It can be operated manually with a switch or automatically whereby a float valve prevents or allows water from the pump to enter the tank, thus turning the pump off or on when needed.

**Photovoltaic (PV) panels** Generally PV panels are used in sets joined in an 'array' of panels that collect sunlight and convert it to electrical energy that can be used directly to power a water pump or (indirectly) to charge batteries if used for pumping or other purposes.

**Reticulation or distribution lines** Network of pipes to distribute water to collection and fetching points.

**Tank or reservoir** Water can be stored in small plastic tanks or large steel tanks. Sizes include 1500-litre tanks for a small system and 20,000-litre tanks for a large system.

**Tower** Raises the water tank in order to use gravity to provide pressure in the water distribution system.

**Treatment plant** Some solar water systems include various technologies (chemical or ultraviolet light sterilization, filtration/absorption of particulates and chemicals etc.) to filter and clean water of contaminants. Using a borehole deep enough to deliver clean water can make such treatment unnecessary.

and particulates from gas flares, while providing itself with more than enough fresh water from deep wells and power from its own massive generators. It therefore did not surprise us that the community was angry about their economic situation and about being asked to regulate their use of the only sources of income available to them. Like other communities, Gbanraun is located near the interface of brackish and freshwater, and residents complained bitterly about the problem of fresh water. They use river water, ponds, shallow wells and seasonally, rainwater catchment for their water needs.

A proposal for a red colobus monkey conservation project was funded by the MacArthur Foundation during the course of NDWC's solar energy training. The project was to take place in the Apoi Creek Forest Reserve area of Southern Ijaw, as part of a multi-organisation grant: Niger Delta – Capacity Building for Sustainable Development (ND-CSD). One element of the grant was for a development project to be selected by the community as an incentive for community-based protection of the monkey and its habitat. This was important, as the monkey's habitat was coming under increasing pressure from the community for its traditional livelihoods of fishing, hunting, and timber harvesting.

### *2.6.2 Design and construction*

A complete participatory rural appraisal (PRA) and sustainable livelihoods assessment (SLA) was carried out with NDWC's field workers, who embedded themselves in the community, working particularly with hunters, fishermen and woodcutters. Following the participatory appraisal, a town meeting was called by the chiefs, at which a water system was identified as their first priority. There were several failed power and water systems in the community; the leaders were strongly against reactivating any of these so-called 'government projects'; and they agreed to our suggestion of a new water system powered by solar energy to avoid the need to keep buying generator fuel. A small water management committee was set up with representatives from the key leaders, and the youth, hunters and woodcutters were involved in the conservation activities.

An ongoing disagreement about the location of the water system delayed the work but it was finally sited in the sticky grey mud of the back-swamps near the residential levee area. A 45-metre well was successfully dug (manually) that delivered potable water; a DC pump was installed, the tower to support the tank was constructed, the tank assembled and photovoltaic (PV) panels were supported above the tank (see Box 2). A float switch in the tank stopped the pump when the tank was full. Even on cloudy days, there was enough power to pump all the drinking water needed. A 'fetching point' with three taps was constructed on a platform in view of the tower. Women, particularly, were vocal in their appreciation of the 'clean water' they now had access to. Chiefs and youth continued to squabble over the location of the system; a pipe was damaged by land clearing (or perhaps sabotage), and taps required regular replacement.

Some problems throughout the project included chiefs fighting over the location, no one agreeing to accept responsibility for supervision, management, discipline and vandalism; and pipes were damaged by the construction of a building by a village elder. A rumour was also started that the water produced by solar pumping caused cholera.

### *2.6.3 Outcome and future sustainability*

Four years after the system's construction – two years after the conservation project had ended – the conservation committee had disbanded, the water pump was not working and a distribution pipe was broken. A recent visit to the area confirmed that the red colobus monkey population, however, was thriving, due to high water during the annual floods making their habitat even more inaccessible than before.

The NDWC trainees in the solar training who were involved in this 'real' project were confronted with the real problems of working in the riverine terrain, and with leaders, youth and women who had varying agendas. These technical and social problems are typical of community-owned rural projects. The continuous demands of leaders, youth and beneficiaries were not based on how efficiently NDWC used transport, labour or time, but rather on people's personal agendas. In spite of carrying out awareness-building activities in the community, there was little evidence of sustained interest in projects serving the 'common good'.

This solar water system has not been functioning for a few years. To re-activate it will require major financial inputs. While there continues to be interest in the endangered monkey, and students monitor its habitat and population growth, no funds for community participation have been made available and no funds for the water system have been accessed by the community. The community was angry about a series of conservation groups who had visited, made promises for re-activating the conservation work, but left immediately and didn't return. However, they claimed to be making some progress in getting the oil company downstream to provide them with a generator and an associated water system. The nearby flow station of a multinational oil company provides power and water to its staff; there is continuing demand by the Gbanraun people for the company to 'share' these services with their community, a practice seldom if ever encountered. There are wealthy individuals outside the community that might have the clout to get funds and technical assistance from the oil company or from the local government, to re-activate and operate the solar-powered water system; recruiting the cooperation of these individuals would require a combined effort from local residents.

Gbanraun solar-powered water system © NDWC

## 2.7 Outcomes of in-house training

Our in-house training provided some initial technical capacity, and the experience of managing solar projects. We learnt, for example:

- Frequent compromises are needed when working with project owners and communities to ensure that solar projects are completed in a manner acceptable to them. This may involve solutions that are not technically the most effective or efficient, or cause costly delays in implementation.
- Importing components for solar energy systems can be fraught with difficulty, starting with tackling the regulations for pre-purchase approvals. The ordering process is tedious, lengthy and complex, due to frequent back-orders and the need to order components from more than one supplier, which must be combined and packed by a shipper who understands West African import procedures, and then shipped via Europe where cargo planes only move when they are filled. Purchasing locally available components invariably requires compromises in quality, although the situation is changing.

## 2.8 Surveys, networking, and building public awareness

Following NDWC's in-house training, we offered employment to some of our trainees. We hoped to cover their salaries by implementing small pilot projects that we could afford to fund internally, and by finding external funding for projects that would expand our experience to more technically complex projects. This would allow us to experiment, improve on local successes and demonstrate the efficacy of solar power in the Niger Delta.

During 2006 and 2007, while we wrote proposals for solar energy development projects to government, development agencies and oil companies, our staff attended conferences and workshops in order to learn, network and source equipment locally. We made trips to Lagos, Port Harcourt and Abuja to see what solar system components were then available locally (up to that time, we had been forced to import many parts). We invited interested parties to see our solar installations, and made presentations to government officials, other NGOs, and the general public. Unfortunately, in spite of our evidence to the contrary, the general public perception was still that solar systems were too expensive, that there was too little sunlight for them to work, and that they were prone to technical breakdowns. This perception was based on badly designed projects that had failed in the past.

### *2.8.1 Solar office and training manual*

In 2006 a Dutch VSO volunteer set up a demonstration 'solar office', with panels and batteries that provided power for two laptops, two light points, and an all-in-one printer/photocopier/scanner. She also wrote an introductory training manual on how to design and construct solar systems (Van Lamoen, 2006) that was made available to the public on our website.

NDWC had hoped to access support for experimental pilot projects and for periodic training courses in renewable energy, with a focus on solar applications and installations. We had hoped that interest in solar energy would increase and lead to fee-paying courses. However, interest in the technology had not yet reached the critical point of people accepting solar energy's potential to solve problems in the Niger Delta. We were also unable to find funds to subsidise the cost to students of our training.

### *2.8.2 Solar-powered systems in Nigeria*

We became aware that even five years before our renewable energy technology (RET) programme started, Nigeria's Delta State had made the enlightened decision to install a large number of solar water systems. Moreover, the Shell Petroleum Development Company (SPDC) had just publicised their plans for a huge solar system nearby, and concurrently, several towns were putting up solar street lights and solar traffic lights.[5] The Japanese development agency (JICA) was taking tenders for the construction of 80 'small solar home systems' over the border in Rivers State. We heard that some contracts for solar projects had been given by state and federal government for refrigerating vaccines, and also for school information technology (ICT) classrooms and water systems, particularly in the northern states.

But while the reports of proposed projects were encouraging, most of the implemented solar energy projects were failing. We decided to carry out independent, unannounced and unfunded visits to collect current information about agencies doing solar energy work, to find out for ourselves what was happening and

5 Most street lights that were installed (e.g. Yenagoa and Port Harcourt) were replaced by electric lights within a year of their installation. Reasons included poor design (too small, not enough light, or battery failure) and vandalism.

why there were such high failure rates. We wanted to know what technical problems were encountered and how these solar systems were being received by their beneficiaries. In 2006, NDWC's Emmanuel Aku, Ngozi Aku, and Miriam Isoun therefore carried out the site visits and reports described below.

### *2.8.3 Survey of solar-powered systems in the Niger Delta*

NDWC visited the sites of 11 solar-powered systems in the Niger Delta. Of the nine that were complete, only four were still functioning. They consisted of one huge project sponsored by Shell Petroleum Development Company (SPDC), one by the US Department of Energy, one by the Japanese Aid Agency (JICA), two by Chevron (the multinational oil and energy company) and seven by the Delta State Rural Water Supply Agency (RUWASAA). Chevron's and JICA's systems were not yet complete. The survey's details of these systems are available in Appendix A.

The SPDC system specifications were eye-watering, including a 50,000-gallon (225,000-litre tank), 600-metre borehole, 30 photovoltaic panels and a cost of US$1.1 million – yet the system proved inefficient at pumping water and only worked for two months. The panels were subsequently stolen. The system provided by the US Department of Energy had not worked since the commissioning ceremony. The four solar-powered systems that were apparently functioning well two or three years after installation were smaller systems provided by RUWASAA, but communities didn't know how they worked or who to contact if there was a technical fault. Two RUWASAA systems had broken down, one was vandalised, and none of them had been repaired.

**Recommendations to RUWASAA**

Delta State is to be commended for its pioneer efforts with using solar energy to power local water systems – for having the courage to 'do things differently'! Following our survey, we offered three recommendations for their solar water systems:

- The first set of these systems, installed in the 1990s, are not working; although they are likely to be repairable. However, it appears that problems arising from the first set were not considered when installing the second set (from 2003 to the present).
- Communities must be part of the process and taught how the systems work, how to maintain them and where to get help when required. There is no evidence of monitoring by government.
- The systems use manual switches to turn off the pump when the tank is overflowing. These are not appropriate, unless someone responsible can be at the well head at all times, which is not practical. Sensors and automatic switches (see Box 2) that turn the pump on and off automatically are relatively cheap; why not use them?

**Recommendations to Chevron**

While networking and carrying out our surveys of solar projects, NDWC had responded to several calls for tender for solar projects from development agencies and oil companies. We were invited to follow up our tenders with site visits on some occasions, and made presentations on the specifications of our designs on others. We found that the funding agencies often knew little more than we did about solar energy systems, and in many cases had less experience. They seemed to trust bigger commercial companies or foreign 'consultants' more than small but experienced NGOs. This was confirmed by the many failed solar street lights, small home systems and water systems that we saw put in place, and then either dismantled, or left dysfunctional and vandalised.

We decided to follow up some unsatisfactory interactions with Chevron and Texaco. In a letter to Chevron we reminded them that NDWC had been invited to get involved in a solar energy

water project in Adagraza community, but our thoughtful proposals and advice had received no response. We explained that our survey had found that solar systems were often ill-designed, whether by oil companies or governments. (The most obvious design fault was technical 'overkill' without technical understanding.) Most of these failed after a brief success. They were more successful when installed with an element of facilitation by an NGO or development agency, but even in these cases, there was no supportive interaction between oil company staff or contractors and community members after projects were completed. Among other questions, we asked why unrealistic and often poorly designed projects are specified in tenders, and why solar systems are designed to mimic earlier grandiose generator projects, when solar is ideally suited – practical and economically – for small, manageable systems. An extract of this letter can be seen in Appendix B.

Opportunities did finally arise for NDWC to carry out sponsored solar water projects, in which we hoped to be able to improve on project design, implementation and sustainability. In the following sections, we describe the major projects NDWC carried out.

# 3
# Niger Delta Development Commission solar water projects

The NDWC survey of solar-powered projects in the Niger Delta confirmed that when state governments and oil companies provide communities with water systems in the Niger Delta, they generally do not give information on how to operate and manage them, or how to get assistance when problems arise. No sustainability plans are put in place as part of the installation contract; these systems are simply handed over to the community leadership at a ceremony. We wondered: if we got the technology right, and worked with the community to design a management plan, could a project be sustained?

An opportunity to carry out this idea came in the form of two contracts with the Niger Delta Development Commission (NDDC), one in Kaiama and the other in Agbidiama. This section describes the NDWC's work with the two communities, both to establish solar water systems and to plan how to sustain them in the long term.

## 3.1 Presentation to Niger Delta Development Commission management

The Niger Delta Development Commission (NDDC) is a major institution established by the federal government which addresses the Niger Delta's specific development issues. We had seen NDDC install numerous failed water projects, based on generator-powered pumps, and were aware that a new administration was committed to giving large numbers of new contracts for water systems. We were anxious to have them consider using solar systems to power the pumps for the new systems.

An NWDC presentation to NDDC in 2004 pressed for the widespread adoption of solar energy systems, and made the following recommendations:

- The main challenge to applying solar energy as the solution to Niger Delta's power problems is education. Many people in the general public don't believe that solar energy actually works.
- We need to develop local expertise. This requires finding ways:
    1. to provide information and training to contractors to ensure that they benefit from work done on successful solar projects
    2. to give local technical trainees guided, practical experience on real projects, for example in NDDC-sponsored Youth Empowerment Programmes, or Industrial Training attachments.
    3. to have a quality control office
        a. to monitor solar projects' completion, and quality of service over time (misapplication of solar technology is worse than not applying it at all)
        b. to provide information on local sources for solar system components, and to assess how components perform in practice.

Following this presentation the NDDC asked the Wetlands Centre to write a proposal for pilot solar water systems. We did so, and recommended installing large numbers of small water systems across the rural areas of the Niger Delta (see Box 3).

**Box 3. Why small solar water systems are best**

*It was clear to us from our surveys that small solar water systems with limited distribution lines have several advantages over large water systems. Small systems are simpler to construct, less prone to faults, and cheaper to maintain. For small systems, water can be stored in plastic 'Geepee'*[6] tanks which are durable and low maintenance, whereas the steel tanks needed for larger volumes of water are susceptible to rust and leaking, and require periodic skilled maintenance. Most communities in the Niger Delta have a population of 10,000 or less. If two small systems were installed in communities of this size, one could act as a back-up if the other needed maintenance or repair. Two small pumps in different parts of the community would mean shorter walking distances between homes and water systems. With smaller pumps required, fewer photovoltaic panels would serve the systems. The number of panels and pumps could be the same for two small or one large system – there is very little economy of scale with this technology. With several drillings, adequate clear water is likely to be found at less than 60 metres – and the wells could be hand-drilled at less expense than deep, rig-drilled wells. If the larger tanks were used, boreholes of 135 to 300 metres would be required and would need to be drilled by leasing rigs, which are costly to transport by land and even more costly by water.

## 3.2 NDDC contracts and site selection

It was two years later, in 2006, that the NDDC gave out contracts for 200 identical solar-powered water systems. The contracts were for large systems: they required a 300-metre borehole, a 20,000 gallon (90,000-litre) steel Braithwaite tank, a 15-metre tower with deep foundations, large numbers of photovoltaic panels and heavy, expensive stainless steel Grundfos pumps (see Box 2). The specifications also included charge controllers, float valves, pipes, and an extensive distribution system with large numbers of water collection points and taps. We made our preference for smaller systems known, but NDDC's design was not negotiable.

We requested a budget line to address ways to sustain the systems during and after construction, so that the huge investment being made would serve the community well over time. This was not approved.

We signed a contract for two of the solar water systems. The sites had been selected by NDDC and assigned to contractors without consultation. NDDC took us to the sites assigned to us; one community told NDDC that they have too many failed water projects already and that they don't need another one. In the next community, NDDC and NDWC were forced to abandon the attempted contractor introduction process, because the community couldn't agree on the siting of the water system. Several months later, NDDC assigned two other villages to us, one in Kaiama (which was ideal as it was served by a road) and the other in Agbidiama, over an hour's boat ride from the jetty at Bomodi in Delta State.

These two NDDC water projects in Kaiama and Agbidiama were huge undertakings for NDWC. They gave us significant experience of working with a large, inflexible agency. They enabled us to test our capacity for the technical aspects of large solar-powered water systems, and our capacity to build in sustainability – the

6 'Geepee' tanks take their name from the manufacturer.

key requirement for development projects' success (despite the lack of budget for this). The next section gives details of the projects' implementation process.

## 3.3 NDDC solar-powered water project in Kaiama

The NDDC Kaiama solar-powered water project contract was signed with NDWC in 2006; successful delivery of water to the community started in January 2009, the first of the two NDDC projects to be completed. It was commissioned by NDDC in February 2012. NDWC are still monitoring and providing support where required to facilitate the project's sustainability.

### *3.3.1 Design and construction*

Having failed to convince NDDC to modify its specifications, the Wetlands Centre decided to meet the specifications, but to engineer beyond them where it seemed necessary for success. The design required heavy civil works for the steel tower's foundation and Braithwaite tank, and heavy rigs for drilling. To make the large number of panels accessible for maintenance and safety, the solar array was designed in two sections, each of which had panels serving one of the two large stainless steel pumps in the borehole, as well as the switch and charge controller. The system we constructed was automatic, with no manual intervention required to turn pumps on and off; when the tank is full a 'float valve' switches off the pump. The reticulation, or network of pipes to distribute water, was to serve a wide area with several water fetching points and multiple taps at each. We imported special heavy duty self-regulating taps designed to 'press down and hold' to release water. These would help conserve water, ensuring that careless users don't leave taps running, and protect the solar pump's lifespan.

First water collection from temporary tap in Kaiama © NDWC

Kaiama solar water system at time of first water collection © NDWC

The photovoltaic panels and pumps were imported to ensure the best quality, facilitated by our solar instructor in Canada.

Major problems encountered in construction were contractor delays, perhaps due to competing projects; problems with hiring rigs for drilling, as the limited numbers available are in high demand; and more than one borehole had to be drilled, due to well walls collapsing and the difficulties of drilling to the required depth. Water was found at shallow levels of the borehole, but they were contaminated with iron. Good, clean water which did not require treatment was only found at 260 metres. The well was cased, tested, and flushed without any problem. The Braithwaite tank was not available locally and so work was delayed while it was purchased and transported un-assembled from Lagos. The stanchion (the upright support for the water tank), constructed to the NDDC specifications and used throughout the Delta, could not support the Braithwaite tank when completely filled. It had to be re-constructed with heavier gauge girders at a cost of just under 3 million Nigerian naira (US$19,000). We discovered that others using the required specifications also had to reconstruct the stanchion,[7] or else regulated the tank's water level for only partial filling.

The 'press and hold' taps that NDWC imported as a contribution to sustainable technology were destroyed soon after the system was in use. They were sometimes pressed up, or sideways, even when instructions and arrowed indicators were displayed. They were replaced with the most robust taps available locally, which continued to require periodic replacement due to damage by misuse. Since the pipe network can be vulnerable to vandalism and sabotage, the pipes used were heavy gauge, placed deep underground. Distribution pipes were indeed vandalised, as described below. Nevertheless, by March 2010, the Kaiama solar-powered water system had been working well for over a year.

### *3.3.2 Vandalism*

When the water system was operating automatically – and later, manually – by responsible individuals, the community beneficiaries were very happy with the system, publicly singing the praises of those responsible. There were no complaints about collecting water from the extensive distribution system's common taps, rather than water being piped to homes. In fact, the use of common taps had the effect that water collected – even from short distances – was only used for drinking. (People have access to plenty of water for other purposes, such as washing.)

But NDWC noticed that the pipe network was vandalised regularly, especially prior to the arrival of thousands of people at the National Youth Service Corps (NYSC) orientation camp. The camp is close to the water system, and while 'Youth Corpers' are grateful beneficiaries of the solar water system, vendors of water sachets lose significant business. NDWC decided to engage security guards to secure the pipe network during these periods, but this was unsuccessful as the vandalism took place at night. The Kaiama solar-powered water system was vandalised 13 times, and each time pipes were broken in several places. NDWC finally decided to pay for the disconnection of 1.5 kilometres of the water system's network and instead install three taps at the wall enclosing the system, which could easily be monitored by the security guard on duty. There have been two NYSC camp periods since, and no vandalism has taken place.

After the water distribution was restricted, the Chief told NDWC's Director that he wanted water delivered to homes. The Director explained that damage to the system must be

7 For instance at Soku, and Elele. We were recently informed of the failure of a recently completed water system in Akassa for the same reason.

avoided in any way possible, as commissioning had not yet taken place, and the NDDC would not pay NDWC for a faulty project.

### *3.3.3 Participatory water resources survey*

We used funds from the recently initiated SUNGAS project (see Section 5) to support a participatory rural appraisal (PRA) of water sources and economic activities in Kaiama. This was to ensure that we learned lessons from the Kaiama project for the demonstration projects that we were to implement under SUNGAS. We assigned two NDWC specialists to the SUNGAS project for this purpose. One is experienced in facilitating PRAs and the other is a community development worker from Kaiama. They produced information on water systems in Kaiama, sources of potable water, and who used it.

The appraisal showed that people in Kaiama have many options for acquiring water: the Nun River, and smaller rivers and swamps are traditional water sources for all uses. There are many shallow, hand-dug wells and several generator-powered borehole systems constructed by various government agencies and development programmes. However, none of the borehole systems produced potable water and many did not work at all. Because Kaiama has a significant population of people who can afford to buy water, there is an active market for 'pure water' in plastic sachets. The fact that pipes were regularly vandalised just before the NYSC camp suggests that the NDDC water system was seen as competing with the water sellers' market. NYSC management contacted NDWC with the suggestion that they could purchase water for the Youth Corps, but they did not follow through, as the town was allowing free access to the water by its citizens.

### *3.3.4 Planning for sustainability*

As a development NGO, NDWC recognises that whether or not funds for sustainability are provided, every development project must involve the beneficiary community from inception to handover. What is required of the community will depend on many variables specific to the location. The minimum, as we had learnt from visits to other projects, is that communities must understand the basic principles of the project's technology and where to get funds and/or assistance when problems arise.

**Water management committee**
From the start of the Kaiama project, NDWC engaged with the community to help plan how to sustain the water system after it had been handed over to them. We met with Chief Burutolu of Kaiama – a retired civil servant with an evident commitment to seeing the lives of his constituents improved – and other community representatives, and it was agreed that a water management committee would be appointed to work with NDWC as the project proceeded. The committee was to implement a management plan as soon as the project was handed over by NDWC to NDDC, and by NDDC to the Kaiama community. At a later meeting, NDWC presented the importance of addressing three issues without which the failure of their water system was inevitable. They were 1) security, 2) implementing a technical management plan, 3) and funds for the first two.

**Security**
There was evidence of security problems in Kaiama, such as the theft of tools from the site, vandalism, unruly groups at taps and mass collection and hoarding of water. It was unquestionable that 24-hour protection of the water system was needed, perhaps by two security guards on 12-hour shifts. We asked the water committee to consider who would appoint these security guards, and how they would be paid.

**Technical management**
For the system to provide continuous service, it would have to be decided how water is to be dispensed, such as a schedule for turning on taps manually, and how the amount of water collected is to be regulated. Each tap should have an appointed person, preferably a woman, who is responsible for ensuring proper use of the tap and reporting damage, conflicts, malfunction and so on to an appropriate person for repair and solution. Responsible Kaiama residents should also be assigned to regular checking of operations, completing a checklist of observations on the components' condition. These would need to be individuals who understand how the system works, and can troubleshoot and report to the appropriate person.

**Financial requirements**
Funding is required to implement the security and technical requirements. The funds required could be substantial, and need to be readily available for repairs and remuneration if the management system is to work. Possible sources of funding include:

- Government: Local Government Area (LGA), Community Development Committee (CDC)
- Community: self-levy, or charge for water collected
- Enterprise: allow a water business to be established which will sell the water to generate the funds required.

Although the chairman of the Local Government Area agreed that it was the LGA's responsibility to provide water systems with federal and state funds, he failed to follow this up.

**Breakdown of the management committee**
The water management committee was unable to agree on a source of funding, and did not report back to us as agreed with a management plan, despite a formal request from NDWC for their report. After many months the committee broke down, necessitating NDWC to communicate with the Chief directly on security and sustainability issues. No means of collecting funds from the community was established. NDWC covered the cost of the security guards at over US$250 per month from 2009 to 2012, when the project was finally handed over to the community by NDDC. No meaningful effort was made to collect fees from the community. Instead, people fetched water at will whenever it was operating, either automatically or manually by the security guards.

### *3.3.5 Visit to Kaiama water system by US commercial attaché*

In January 2010, a team led by the commercial attaché of the US Embassy in Lagos visited the Kaiama water system. This rather high-profile occasion gave NDWC the opportunity to bring together NDDC, LGA, Kaiama leaders and other NGOs to highlight the success of solar water pumping, as well as deep boreholes for the provision of potable water. We also stressed the challenges of ensuring such systems were sustainable, hoping to engage participants in making contributions to how they thought this could be done. The US embassy visitors spent a long time on technical issues; the community made promises to show their gratitude for the water system through good management, and NDDC thanked NDWC for a demonstrably successful project. Still, they delayed two more years before commissioning the completed project.

### *3.3.6 Relations between NDDC and NDWC*

NDDC had not shown an interest in our project during the construction phase or even during more than six months of water production. They had approved interim certificates for the work but they were delaying the commissioning for unexplained reasons. This surprised us as we heard reports that of the 200 systems contracted at the same time as ours, our system was one of only a few that were functioning

(see Section 3.5 for a survey of other NDDC projects.) However, one top NDDC official was reported to be impressed with the performance of the Kaiama system, and a Bayelsa State NDDC representative visited the project; he was intrigued that the NDWC project was one of so few that were working. NDWC urged the community to work through the Governor, the local government officials and the NDDC directly, to get the project commissioned and handed over to the community for management.

### *3.3.7 Commissioning*

Finally, commissioning – the official 'launch' of the NDDC Kaiama solar-powered water project – took place in Feb 2012; a new chairman of the NDDC Board who was from Kaiama knew about our project, and chose to associate himself with it. Thus the reception of the chairman by Kaiama and the commissioning of the water system by NDDC took place on the same occasion.

The NDWC presentation at the commissioning called on the NDDC to reform some aspects of NDDC project design and management systems; to hold contractors accountable for completing successfully performing projects, and to facilitate the sustainability of solar water systems following commissioning in all contracts. We also offered to carry out targeted training, from capacity building of senior design engineers to community troubleshooting and training maintenance technicians.

### *3.3.8 Outcome and future sustainability*

Following the commissioning in February 2012, NDWC staff reminded the Chief that they had been maintaining the project for three years outside of their contract; and this NDWC support must now end. NDWC urged the Kaiama community to take appropriate steps to generate funds to maintain the system, suggesting that:

- The Kaiama community might collect rates or charge for water collected – people tend to take better care of services that they pay for than those provided for free.
- Some well-to-do Kaiama citizens might be willing to contribute to the cost of upkeep of the system.
- The LGA could be convinced to use its relevant subventions to pay for some of the costs (such as deploying security guards, monitoring distribution, or providing technical assistance).
- NDWC staff are willing to continue to serve as advisors and facilitators in accessing third-party funds if so requested.

Once the Kaiama water system was handed over to the community, the Chief took responsibility for paying for the security guards who operated what was, by then, a manual system. Although the security guards gave preferential treatment to some – at one point preventing people from collecting drinking water while they supplied water to a nearby construction site instead – the system continued to function. A visit to Kaiama in May 2013 found the system working well and a security guard on duty. The guard reported that the water supply continued to meet people's needs.

If the Chief continues to fund security, manual management of the currently restricted distribution, maintenance and minor repairs (such as damage to taps or pipes) the system will continue to function. If there were to be major faults (to the pump or charge controller for example) the Chief would probably be able to use his influence and get repairs and parts replaced in cooperation with NDWC.

**Box 4. The 2012 Niger Delta floods and solar-powered water systems**

The heavy rains and unprecedented floods of 2012 in the Niger Delta forced many villages to be evacuated and others to accept refugees. Roads were closed; banks didn't receive funds for people to sustain themselves; fuel was not delivered for generators used for light and water pumping; flooded water systems and generators were inaccessible. In nearby Odi, one of our staff reported, 'People would pay more to have a canoe than to have a jeep!'[8]

In Kaiama, although sections of town were damaged, movement was mostly possible, and resident families were forced to accommodate others displaced by the floods. Kaiama's Chief later wrote a letter to NDWC that graphically illustrated why solar water systems are so practical for providing potable water in the Niger Delta terrain: Kaiama's system continued to function throughout the floods, as no fuel was needed to power the pumps. The contents of this letter spread quickly and NDWC has had numerous requests for information on solar-powered water systems 'in preparation for the next floods'. The Chief wrote:

'The project has impacted positively on the Community by serving the NYSC as an institution and the entire Kolokuma/Opokuma government area during the ravaging flood. One can imagine what would have happened to the whole camp of (5–10,000) refugees if this provision were not there. We stand to appreciate this singular contribution to the development efforts of the community.'

## 3.4 NDDC solar-powered water project at Agbidiama

The second NDDC solar-powered water system was sited at Agbidiama, an off-road village in Bayelsa State accessible only by the costly daily hire of outboard motorboats. The system was to be constructed concurrently and with the same technical design as the Kaiama system. The contract was signed late in 2007.

### *3.4.1 Construction*

Soil tests and initial relationship building with the community occurred within weeks; mobilisation to site and digging the raft foundation took place in March 2008. The borehole was drilled and by May 2010, equipment orders for tower and tank components were ready for delivery; some items were transported to Agbidiama from Lagos and others from Yenagoa to Bomodi. Accommodation for staff and rental space for materials (valued at over US$44,000) had to be found at Bomodi. Then local speed boats were hired for smaller items and labourers, and a barge hired at great expense for the large items. Once in Agbidiama, more storage space and staff accommodation facilities needed to be hired.

Transporting the drilling rig, pipes and chemicals and so on for the borehole was difficult. There were repeated delays, both because the inaccessibility of Agbidiama created logistical

8 'Community members in these parts live with the annual floods; and understand what to expect. But the flooding which occurred in parts of Nigeria in 2012 is the country's worst in living memory. As a septuagenarian in one of the affected communities in Rivers State puts it: "we have never seen anything like this before. Even my parents never told me of such flooding in the past". In Bayelsa State, 80 per cent of the state was covered by floods as six out of its eight Local Government Areas were affected. In Rivers State, 183 communities were affected and 830,000 people were displaced by the floods' (Vivian Bellonwu and Ken Henshaw, 2012).

problems for rig owners to move their equipment to site, and because social unrest in the area caused recurrent security problems en route to the village. Even when NDWC was mobilised on site, local leaders and young people caused period shut-downs due to various demands and disruptions. This put increased pressure on NDWC to get the work done quickly without attracting undue attention. On one occasion when our staff were absent from the site, one of our local contacts took blocks and cement left there for our use on our return. We were able to recover the cost of those goods from that individual, with difficulty, but petty theft continued to be a problem, mainly by workers.

The plan to drill down to an aquifer with iron-free water necessitated that we drill three boreholes. Construction of the foundation and tower, installation of the Braithwaite tank and pump, and the first 500-metre phase of reticulation proceeded without incident; reticulation was extended to triple that length (as specified in the contract). NDWC was proactive in identifying people who had worked with us during the construction to act as contacts, to troubleshoot and report problems to us while awaiting final commissioning.

By the end of January 2011, the system's solar panels and array were in place, water testing confirmed potability, NDDC's final inspection was complete and the project was approved for commissioning and final payment. We turned the automatic system on, leaving a CDC official in charge who had been instructed in how to monitor the system and troubleshoot problems. The project was all set to be handed over to NDDC, and in turn handed over to the community.

### *3.4.2 Post construction problems*

It took NDDC three years to get around to taking over the project and completing payment to NDWC for its work. During this period, NDWC responded to several reports of leaking pipes and damaged distribution lines and taps. In April 2011, NDWC was called about problems with reticulation and the float valve. NDWC immediately carried out extensive repair work, spending over US$630 to introduce three control valves and repair damages to the reticulation line. The control valves were to ensure that if one section of the reticulation had a problem, the other two sections would continue to function without the entire water system needing to be shut down. The community was advised about managing the reticulation, and that reporting faults was essential for the operation of their automated solar-powered water system to continue.

In late 2012, we received a report that the pump was no longer working. We found that the distribution points had been broken in several places, and the leaking water had caused the pump to work continuously for some weeks before NDWC were contacted. As a result, the stainless steel Grundfos pump had melted.

We had to ensure that the Agbidiama water system was functioning, since the NDDC had just announced it was ready to commission it. NDWC replaced the solar DC pumps and told the community it was going to disconnect the distribution lines and install three taps at the site of the pump only, as it had done at Kaiama. The community was belligerent and threatening, and insisted that the commissioning would not be allowed to proceed without full replacement of the reticulation throughout the town. This was done: NDWC staff reconnected the distribution lines in preparation for the commissioning, which was planned within the next few days. The cost of these repairs was over US$3000.

The system was working at the time designated for commissioning. However, NDDC did not formally hand over the water system to the community, or to any designated representative or monitor; or put any plan for monitoring and troubleshooting in place. NDWC was, however, paid in full for its work.

### 3.4.3 Outcome and future sustainability

The system was still working three months after the pump replacement and reticulation repairs took place, but we expect that it will break down soon. As there is no plan in place for either the community or NDDC to sustain it, it will be just another failed solar water project.

## 3.5 Other solar energy projects in Nigeria

The NDWC carried out surveys and read reports of other solar-powered projects in the country. We made site visits to a selection of NDDC's other water systems; saw two solar energy projects by the Energy Commission; and read government agency reports of other solar energy systems. This section describes our findings.

### 3.5.1 Survey of NDDC solar-powered water systems

As we met the various challenges and completed our two NDDC solar-powered water projects in Kaiama and Agbidiama, reports came in about the failure of some of the other projects contracted concurrently with ours. We visited three of these failed systems independently, and arranged a more formal trip to four others in Rivers State in April 2010, accompanied by a cameraman and member of the Movement for the Survival of the Ogoni People (MOSOP), both from the Ogoni area. This activity was funded by the SUNGAS project, as part of our lesson learning in preparation for the demonstration projects. Brief descriptions of the four Rivers State sites – three in Ogoni and one in Andoni – are in Table 1.

**Table 1: Site visits to NDDC solar-powered water projects**[9]

| LOCATION 1: BARAKO, GOKANA LGA, RIVERS STATE | |
|---|---|
| **Type**: *Large solar-powered water system sponsored by NDDC*<br>**Status**: *Incomplete*<br>**Contractor name available:** *Name of contractor on signboard*<br>**Progress:** *Project started 2007 and not yet completed (in 2010). Borehole, stanchion and tank are in place, but no reticulation or solar system yet*<br>**Depth of borehole:** *Contract for deep borehole (300m)*<br>**Quality of water:** *Not known; no treatment plant in design*<br>**Security:** *Fenced and padlocked; no vandalism reported.* |  |

9 See Box 2 for a glossary of some technical terms used below.

## LOCATION 2: YEGHE, GOKANA LGA, RIVERS STATE

**Type:** *Large solar-powered water system sponsored by NDDC*

**Status:** *Not functioning*

**Contractor name available?** *Not for either contractor (one for civil works, another for solar components)*

**Progress:** *Project started in 2007; completed in 2009. It worked for 5 months but is no longer functional*

**Components:** *9 panels, Braithwaite tank, 13m high support tower, 3 batteries. Unable to get more specific data. Inverter at site, but it was damaged after a long periods of continuous operation ('they saw a spark in the inverter and it did not come on again')*

**Depth of borehole:** *Contract for deep borehole (300m)*

**Water quality:** *Quality of water was good. No treatment system*

**Security:** *Fenced and padlocked. There was no vandalism.*

**System operator:** *A local resident employed by the contractor but who has not been paid. Water turned on manually in the morning and turned off at 3p.m.*

## LOCATION 3. NEAR SII, GOKANA LGA, RIVERS STATE

**Type:** *Large solar-powered water system sponsored by NDDC*

**Status:** *Functioning*

**Contractor name available?** *Name and address on signboard*

**Progress:** *Project started 2007, completed 2008. Has worked from commissioning to date (2010)*

**Components:** *16 Solar World panels, 1 pump, 1 Braithwaite 20,000-gallon (90,000-litre) tank, Grundfos charge controller (0.58kWp), no battery*

**Depth of borehole:** *Contract for deep borehole (300m)*

**Support tower:** *13m high*

**Water quality:** *Good; no treatment*

**System operator:** *A local resident. Water is pumped for 2–3 days and the water collected is emptied within 3 hours. The operator told us that the Paramount Ruler (chief) of the community gave instructions to people to pipe water from the distribution line to their houses.*

**Security:** *Fenced and padlocked. Community youth take care of the clearing and security*

**Vandalism:** *Thieves stole four of the 20 solar panels – the system is now powered by only 16*

**LOCATION 4: OFF ROAD (VIA BOAT) IN NGO, ANDONI LGA, RIVERS STATE**

**Type:** *Large solar-powered water system sponsored by NDDC*

**Status:** *Incomplete*

**Contractor name available:** *Name and address on signboard*

**Progress:** *Project started 2007; is ongoing. Still at raft foundation stage*

**Components***: Will be similar to other NDDC water projects in this set of contracts.*

**Community involvement:** *We observed a ring well fenced inside the project site. The community alleged that the contractor intended to use the ring well as a borehole. They told us that this led to the setting up of a committee to discuss the issue with the contractor.*

**Security:** *Fence without a gate. Two community members monitor the site.*

Source: NDWC Report prepared by Emmanuel Aku (April 2010)

### *3.5.2 Energy Commission solar systems*

The Energy Commission has published a booklet on their solar projects, including two solar systems near Abuja.[10] One of these is a solar-powered water system at the Federal Government College, Kwale, and the other is solar electrification for an ICT lab at Gwagwalad School for the Gifted. As part of our survey of solar project sustainability, NDWC staff visited the two sites unannounced in April 2010.

We found that the water system at the college in Kwale had worked for a short while, and then the photovoltaic panels were stolen. At the School for the Gifted, we saw two photovoltaic panels, both 125 volt-ampere, but it was not clear if the system was working and no computers were visible in the ICT room. We were unable to find out more, as at that point the Principal told us we had no right to look around.

10 See www.energy.gov.ng for the Nigerian Energy Commission website.

### 3.5.3 Other solar-powered systems in government agency reports

NDWC had access to several lengthy unclassified publications through the Federal Ministry of Science and Technology, including status reports of projects carried out by the Federal Energy Commission, NDDC and other agencies. The reported solar-powered projects were mainly for powering computer laboratories to provide internet services in schools, for refrigeration of vaccines in medical facilities, and for powering pumps for water systems. The data was overwhelming in showing the inadequate performance of these projects. Most of the projects were incomplete three years after contracts were signed; many others were abandoned as 'failed' soon after commissioning, or vandalised. A very few were apparently successful; these need to be assessed through periodic site visits.

### 3.5.4 Summary

This research confirmed the depressing pattern that had emerged in our 2006 survey – that the majority of solar energy projects fail and are abandoned either shortly after commissioning, or even before they are completed. A few systems are functioning well, but if the communities who own them have no plan or understanding of how to sustain them – which experience suggests is very likely – there is little guarantee that these systems will be long-lived. This conclusion encouraged us to keep our focus on the key issue: how can solar-powered projects be sustained?

# 4
# SUNGAS: focusing on sustainability

By 2009, NDWC had accumulated information on the environment, water resources, and availability and means of accessing potable water in the Niger Delta. We also had experience on the ground of using solar energy systems in Nigeria, including the Niger Delta. Our experience with solar-powered water systems included the construction of both small systems and very large systems, some designed by us, and some designed by third parties.

NDWC's ongoing Renewable Energy Programme was coming to the conclusion that the main challenge to solar-powered water systems in the Niger Delta was bad press caused by the failure of numerous solar energy projects. These failures were due in part to inappropriate technical design, but mainly to a lack of socio-economic sustainability. There were technical problems that we encountered, solved and learned from. It was straightforward to change taps, replace pipes and even stanchions and girders; it was simple to adjust float valves, to repair and protect charge controllers shorted out by insects (see Box 2). It was even possible to 'recondition' pumps that had seized up due to an unexpectedly low water table or over-pumping due to damaged distribution lines. Far more challenging, however, was ensuring the sustainability of water systems once they were completed and shown to function effectively. We would begin the process of raising sustainability issues with the beneficiary community the moment we entered the community, and continue during project construction; but once the project was completed, community group participation invariably broke down. People seemed to feel that 'things would take care of themselves' or that they could deal with problems ad hoc – 'if and when they arose'.

A major frustration we had with our projects was that sponsors of water projects never built in funding for sustainability planning or implementation. None of the sponsors of our projects would agree to a reasonable budget line for this socio-economic issue. They expected the community to simply take over from them once the project was commissioned. NDWC was committed to proving that solar systems really worked, and therefore could not leave the project simply because construction was complete. We did what we could to make repairs, provide security, and put pressure on key stakeholders to invest in sustaining their own water systems – to invest in self-sponsored sustainability for the common good, or even for self-interest. We had not been able, however, to introduce any community-level governance or funding mechanism that could sustain a solar-powered system without our continued intervention.

## 4.1 The SUNGAS project

A European Union (EU) sponsored project seemed to offer us the opportunity to focus on this central problem of sustainability in solar energy systems. The SUNGAS project was the result of a partnership between NDWC and the London-based International Institute for the Environment and Development (IIED), along with other partners, the Living Earth Foundation and their local branch, the Living

Earth Nigeria Foundation, and the advocacy NGO Social Action.[11]

The project proposal to the EC was written largely by the IIED. The proposal development process was led by an independent expert, Brian Shaad, who had good knowledge of Nigeria and all the Nigerian project partners, and had been trying to set up a similar project for a long time. The NDWC element of the proposal was based on a previous proposal written by NDWC. All partners contributed to the final proposal to a greater or lesser extent, via email and/or telephone conversations, and face-to-face in the case of those based in London. Nonetheless, all partners felt that it would have been helpful to have had much more direct contact and face-to-face time in the development of the proposal so as to build greater trust and mutual understanding about project objectives. However, this was difficult due to the lack of available funding for this kind of pre-proposal activity. This is an issue faced by many new development partnerships.

The scope of the IIED proposal included, in addition to renewable energy projects, small gas-powered turbine energy systems and a strong advocacy component, with the aim of influencing energy policy and public awareness of decentralised energy issues. The focus of the 'renewable energy' and 'gas-to-power' components of the IIED proposal was on ensuring that projects developed under the EU funding demonstrated technical, financial and social sustainability. It identified this key to successful projects: the requirement that *a working sustainability plan be in place* at the completion of a project's construction. The SUNGAS project therefore offered NDWC the chance to do something it could not get funded by oil companies and other construction-focused sponsors. This was a perfect opportunity to look closer at sustainability options for existing projects; and to initiate new projects with sustainability options built into their design and implementation.

NDWC therefore decided to participate in the IIED proposal. The SUNGAS project was attached to its Renewable Energy Programme. The SUNGAS project officially started in April 2009, with a first meeting for project partners in the Nigerian capital Abuja, in May 2009. The project was officially launched in Abuja, in December 2009.

## 4.2 Work carried out under the SUNGAS project

During the lifetime of the SUNGAS project, NDWC's scope of work consisted of the following:

1. Project preparation
2. Documenting renewable energy technology (RET) in Nigeria
3. Exploiting synergies between NDWC projects and SUNGAS
4. IIED and SUNGAS partner group activities
5. SUNGAS pilot project: Aduku
6. SUNGAS pilot project: Odi
7. Opportunity project arising during SUNGAS project: SPDC water system in Bomoundi

8. Review of SUNGAS project outcomes

Activities 1 to 4 are described in more detail below; the pilot projects are covered in later sections.

## 4.3 Project preparation

Project preparation included drafting documents to guide the design and implementation of RET projects once selected; and to inform the content of a presentation to be made at the launching of SUNGAS in Abuja to a gathering of key national and

11 Following changes in the project partners, the current line-up is IIED, NDWC, LEF (together with local partner the New Nigeria Foundation) and new advocacy partner Stakeholder Democracy Network.

international stakeholders. Team building was carried out with IIED and other partners, as well as drafting conceptual agreements, and agreeing on bureaucratic processes, reports, meetings and so on. Log frame analyses, risk assessments and a discussion of visibility issues were undertaken.[12] This was followed by the signing of contract between the EU and IIED, and a Memorandum of Understanding (MOU) between IIED, NDWC and the other partners. NDWC recruited three graduates for the SUNGAS project who worked alongside NDWC staff and various sectoral experts.[13]

NDWC's extensive data collection and site visits, reported in Section 2, provided the basis for collating research and surveys on RETs and solar energy projects in Nigeria.

## 4.4 Synergies between SUNGAS and other NDWC projects

During the lifetime of the SUNGAS project, opportunities arose for NDWC to carry out various other projects, which benefited from synergies that we created with the SUNGAS project. These projects included:

- The Kaiama Solar Water Project sponsored by NDDC (see Section 3.3. above)
- A renewable energy training course funded by a Royal Dutch Embassy grant (see Section 4.4.1 below)
- Renewable energy advocacy work for the Rivers State Ministry of Environment (Section 4.4.2)
- Collaboration with energy researchers from 'D-Lab', a sustainable energy research group at the University of California in Berkeley (Section 4.4.3)
- The SPDC Bomoundi-Ekpetiama water system carried out later in the SUNGAS project, which also benefitted from NDWC's experiences on its SUNGAS pilot projects (Section 6.2).

### *4.4.1 Renewable energy course*

The Wetlands Centre ran a three-week course in 2009 on renewable energy with a focus on solar energy, funded by a grant both from the Royal Dutch Embassy with support funding from SUNGAS for renewable energy capacity building.[14] The objective was to build much-needed capacity and awareness on renewable energy, as well as to debunk myths about solar energy systems. Trainees were invited from communities in which we were establishing solar projects. These included the NDWC Finima Conservation Project in Rivers State; a private ISP in Abuja; a development NGO in Akwa Ibom State; and unemployed and privately employed youth in Bayelsa State.

**Course objectives**

NDWC's Director explained the reason for the course, and the diversity of its participants. An extract of her speech on opening day follows:

We all know that power is required for delivering the most basic of human services and healthy, safe and secure living. But we all also know it is unrealistic to expect governments to connect all villages to the grid, whether through overhead

12 'Log frames' are logical framework analyses or LFAs. 'Visibility' refers to raising the profile of a project's sponsor, e.g. through the use of the sponsor's logo on equipment or signs.

13 The graduates recruited were Chrison Ayegheleme (Computer Science graduate), Dedekien Simeon (Project Management graduate) and Sophia Wariebiowei (English graduate). NDWC staff who worked on the SUNGAS project as appropriate included T. T. Isoun, M. Isoun, E. Aku and Uyalakumo Iti. The sectoral experts included Dimie Otobotekere (PRA/environmental science expert), Gbabra Yoruba (of the Bayelsa State Ministry of Environment), and Ilse van Lamoen (of Theatre for Development).

14 By the time the training started, the SUNGAS project was about to take off; some SUNGAS funds were approved for expenditure on specific training costs as it was agreed that there was synergy between the objectives of the Royal Dutch Embassy's grant and the EU's SUNGAS grant.

power lines or underground, especially in the central Niger Delta. We have all asked: if stand-alone generators don't work and grid connection is not coming for 50 years, are there any alternatives for providing energy for essential power needs? Furthermore, where government has put power systems in place the sustainability record of these systems is abysmal. NDWC believes that solar energy offers distinct advantages over the conventional fossil fuel generator and gas turbine, kerosene and firewood options. If solar systems are to be adopted and sustainable, we need to expand the visibility of successful solar projects.

NDWC has a few new projects on the horizon and we are determined that our projects succeed. We therefore need to have personnel at various levels of the projects' implementation:

- We need people who have seen solar projects work, have a basic understanding of how they work and can be advocates for the technology at community level. They can counteract the stories that solar energy is a 'cheap alternative', 'causes cholera', 'doesn't work', 'spoils quickly', and so on.
- We need people who can interact with community and project implementers, facilitating project monitoring and troubleshooting to ensure sustainability.
- We need people who can implement well-designed projects – who, given a design that has been piloted in the Delta, can construct the project, test it, and with the designers, get it inspected, and monitored over time.
- We need people who can design projects, understanding the details of design requirements to provide sturdy, reliable systems. They will understand the importance of using the right tool, the right component, and the optimal quality of construction materials. They will anticipate technical problems and challenges and build solutions into projects.

NDWC is hoping that you – or people you train or work for – will carry the good news about alternative energy in one way or another, and that you will see us at NDWC as your partners in this. We can serve as consultants when you need advice, or we can serve as employers where your services are needed. We hope you enjoy this course and we hope you will continue to work with us over time.

**Course content**

NDWC staff designed and delivered the training in solar energy, with NDWC's Emmanuel Aku taking the lead. The solar energy components of the course involved both lectures and practical hands-on work and calculations. The students worked with manuals written by NDWC staff and a Voluntary Service Overseas (VSO) volunteer. Simple tool kits were provided to allow each student to carry out practical work individually.

A retired engineer from the USA also volunteered to assist with teaching structured problem-solving approaches and the appropriate use of tools. He also introduced the principles of wind turbines, working with the students to reactivate a wind turbine we have used in the past and to set up a newer, larger wind turbine.[15] This turbine was delivered during the course by visitors from China who were interested in supporting renewable energy developments in Nigeria.

Dr Egwim Evans, of the Federal University of Technology in Minna, Nigeria, presented an introduction to biomass as a source of biofuel. His presentation of work at the frontier of these new energy technologies strengthened the class's commitment to work towards the energy mix of the future.

15 One kVa (kilo volt-ampere)


NDWC training in wind turbine assembly © NDWC

The course included weekly field trips to solar installations.[16] Failed systems gave the students an opportunity to troubleshoot, while successful systems enabled them to recognise features that contributed to their success. Students were also exposed to current global energy, climate change and global warming issues through lectures and the latest audio-visual materials.

**Course outcomes**

The course succeeded in:

- creating informed advocates who are committed to building awareness of RETs
- building capacity to monitor and troubleshoot solar and wind-powered projects and implement RET projects under supervision
- providing some students with the skills required to design and implement site-specific solar and wind-powered projects.

### *4.4.2 Rivers State renewable energy programme*

The Environment Commissioner of Rivers State was committed to renewable energy initiatives in the state, which were receiving funding from the World Bank. He supported plans by independent consultants Chris Newsome and Simon Gusah to build awareness of RET among the general public and the state government. Between November and December 2010, NDWC's SUNGAS team contributed to these activities by preparing programmes for radio with skits and jingles, and participating in talk shows focussing on RETs, global warming, climate change, air pollution and water contamination. NDWC's Director and the SUNGAS coordinator made presentations to Rivers State government on its experiences with solar energy projects at a meeting of key stakeholders in energy provision for the state, which was attended by the World Bank and other development agency representatives. When the Commissioner later left office for an elected office in Abuja, however, commitment to renewable energy at the Ministry broke down, and the World Bank put its support for Rivers State's renewable energy activities on hold.

### *4.4.3 Energy needs and use assessments*

Project consultant Brian Shaad introduced NDWC to a team of sustainable energy researchers from the University of California ('D-Lab'), who visited Aduku (the site of the first SUNGAS-NDWC pilot project) looking at the potential for renewable energy access based on small lanterns and mini-grids. They visited communities and circulated 'energy diaries' to research how energy was used; they also demonstrated solar power lamps and looked at the potential for installing mini-grids (see also Section 5 below).

16 A successful ICT laboratory in Okoloba implemented by Yentech with some contribution by NDWC's staff; Small Home Systems sponsored by JICA; and several solar water pumping systems in Delta State.

## 4.5 IIED and SUNGAS partner group activities

Several activities were held in Nigeria with IIED and the other SUNGAS partners, where the experiences of the RET sector, the gas-to-power sector and energy policy and advocacy were shared. These included regular review meetings, public workshops, and training workshops. Review meetings were valuable for sharing experiences and working out issues arising from implementation, and funding challenges. Other activities enabled IIED to participate in NDWC's training activities and to visit project sites on a regular basis.

### *4.5.1 Participatory community development training workshop*

A training workshop was held at NDWC that included representatives from communities where NDWC projects were located. Facilitators included the NDWC SUNGAS participatory rural appraisal (PRA) team and a MEND/Theatre Alliance team.

## 4.6 Challenges of the SUNGAS project

Meeting the objectives of the multi-focused and multi-organisational SUNGAS project turned out to be a challenge throughout the life of the project, particularly in three areas:

1. Technical challenges with site-specific design issues of sustainable solar-powered water systems (some issues were specific to the Niger Delta and some to particular communities)
2. Socio-economic challenges to delivering development projects which could be sustained over time in diverse communities
3. The unanticipated bureaucratic complexity of meeting the reporting requirements of the project sponsor, the European Commission, and the managing NGO, IIED.

From the first meeting and throughout the SUNGAS project, the IIED (as the EU project managers) had regular interaction with the project partners. During these often intense discussions, partner staff described the realities of implementing the SUNGAS project, revisiting risk assessments, log frame analyses, visibility requirements and presenting their concerns about meeting contractual details. The NDWC found the narrative and financial plans and reports demanding and sometimes inconsistent with the way things work in our environment.

## 4.7 SUNGAS demonstration projects

The SUNGAS project aims to build understanding and awareness locally about the potential to implement sustainable energy access projects in the Niger Delta. A large part of this is through the implementation of practical demonstration projects and the dissemination of lessons learned.

NDWC carried out two SUNGAS demonstration projects, one in Aduku and the other in Odi. These are documented in detail in the next two sections, along with a report on an SPDC contract to construct a solar water system in Bomoundi. The latter project also satisfied an objective of the SUNGAS project, which is for SUNGAS to influence wider practice in the Niger Delta, through replication and adaptation of the experiences of the SUNGAS demonstration projects.

# 5
# SUNGAS demonstration project in Aduku

The focus of the SUNGAS project is *sustainability*. This means building a lasting energy system that is eventually owned and maintained by the local community, who benefit from it in the long term. A sustainable project benefits the community it serves and demonstrates the 'wise use' of donors' funds.

NDWC was delighted to take part in a project that enabled it to focus on sustainability rather than technical issues alone, although of course the two are related. Huge effort therefore was put into the sustainability of the SUNGAS pilot projects, using what we had learned from other Niger Delta development work, and doing what we had been prevented from doing on other projects by finances, time or sponsor-imposed constraints. We approached 'sustainability' as a participatory process from the time the site was selected, using typical PRA tools and meticulously documenting observations, data collected and analysis.

The first and more intensive of the two NDWC-SUNGAS pilot demonstrations was sited in Aduku, located between the Nun and Forcados Rivers and midway between Trofani and Odi. This project set out to demonstrate community-based management of a renewable energy-powered development project, with community participation from inception to the point of handover to the community.

## 5.1 Site selection

The process of selecting sites is important to the possible success of any community-based project. We selected 10 communities of which we had some basic knowledge or connection. Aduku was selected for the first pilot demonstration, based on the following criteria.

**Table 2. Criteria for selecting pilot project site**

| CRITERION | ADUKU, SANGANA LGA |
|---|---|
| Logistics (accessibility) | Yes – served by a road |
| Enlightened traditional leadership | Not known, but seems positive |
| Militant/difficult youth | None evident |
| Inter-communal conflicts | No |
| Oil industry presence/problems | No |
| Community support from elites | Yes |
| Failed development projects | World Bank water system |
| Successful development projects | None identified |
| Size: large, medium, small (indicating 'wieldiness') | Small |
| Land use issues | Probably |
| Economic productivity | Very good |
| Security for SUNGAS staff | Good |
| Visibility | Good |
| Community institutions in place | Not known |
| Willingness of community to contribute to costs | Not known |
| Known to NDWC | Yes |
| Connected to power grid | No |

## 5.2 Community entry

Having tentatively selected Aduku for a SUNGAS pilot project, informal visits were made early in 2010, first by NDWC's Director and management staff, and later by visiting IIED representatives. Aduku made a good impression; people were industrious and approachable, and the compounds were neat. NDWC and SUNGAS staff arranged to meet Chief Emberru, the chief of Aduku, a former civil servant who was familiar with the work of NDWC, for formal entry into the community.

At this public meeting in May 2010 we explained that we wanted to demonstrate that solar water projects could be successful by involving communities as 'owners' of the projects. We explained that this would require investment by the community in managing and financing them once they were commissioned. We also introduced our PRA survey experts and the

SUNGAS team who would be living with them for several months to identify their needs and priorities and to discuss ways to address them.

## 5.3 Participatory rural appraisal

Over a period of more than three weeks the SUNGAS team and its Aduku counterparts collected environmental and socio-economic information to help understand the community's structure and function, its resources and livelihoods, and its priorities for improving people's quality of life. The team used the PRA tools as appropriate; these included transect walks, area mapping, focus group discussions, triangulation, direct observations, semi-structured interviews, ranking and scoring techniques, diagramming, and so on.[17]

Some of the gathered information follows.

### *5.3.1 Background*

The community presented the 400-year history of Aduku in great detail. Its history of migrations, settlements and economic activities explain its current social setting. Aduku's land is owned by four families in Abari, across the river from Aduku. In the past they farmed its fertile soil and gathered forest products, but now they rent this land to people of other ethnic groups. (This practice occurs throughout the Niger Delta.) Those now living in Aduku farm, fish, harvest timber and process foods, but recognise their homes as being elsewhere. There are over 100 of these families, who are considered to be 'tenants' rather than 'settlers' by the Abari people. Residents' investment in Aduku is limited, since they are not owners of the land; for instance, they are not allowed to construct permanent residences or schools.

Crops grown in abundance include cassava, water yam, plantain, sweet potato, red pepper and palm fruit. Garri (tapioca made from cassava) and palm oil are produced for the market, as well as palm kernel, plantain, and timber. Farming here is lucrative, and produce is now sold in the weekly Aduku market on a road recently constructed by the NDDC between Odi and Trofani.

Before the road was built, Aduku was accessible only by water or footpath (it is located on the Forcados River and along the Aduku River connecting it to River Nun. This road has put Aduku in a strategic position for expanding commercial activities and development, and opened up access to formerly remote forests, which are being heavily exploited for timber and other products. However, the community has local by-laws regulating some of their resources. Commercially valuable trees such as ogbono and iroko cannot be cut down; fish are harvested at regularly scheduled intervals – in some cases, intervals of several years.

### *5.3.2 School and health centre*

The free primary school in Aduku is a 'Federal Government Migrant Fishermen School'. There are six classrooms; 142 boys and 117 girls are enrolled, although it is rare for even half of this number to be present. Children are often away to help parents farm or fish, and there are numerous holidays and closures for staff and school administration activities. The school has no sanitary facilities, water or staff room. There are 20 staff, several of whom are away regularly to complete their teacher training. The school seldom receives the approved teaching aids, books and equipment. One room in the school is used as the Aduku Health Centre. It is staffed by a trained nurse, who is rarely present, and there is no equipment, medicine or water.

17 For more on these methodologies see: www.wau.boku.ac.at/fileadmin/_/H81/H811/Skripten/811308/2_WorldBankparticipation.pdf

Aduku children and teachers at the Aduku solar water system © NDWC

### 5.3.3 Energy

Several families have small private diesel-powered generators. They use them to power lighting, radios and refrigeration for selling chilled drinks. Fuel is expensive and generator technicians are not available in Aduku. Kerosene is sometimes used for light and cooking; torches and oil lamps are also used.

### 5.3.4 Sources of water

Swamp and lake water is used for drinking and cooking without being treated. People believe that the tree leaves which drop into the water purify it and prevent sickness. We were informed that water is in great demand during the dry season, when even the river dries up. People only buy packets of 'pure' water for visitors. Water from the manual pump is coloured, so it has never been used. There was a World Bank water project attached to the school that supplied water for a few months before the pump broke down. It has not been fixed, and the generator, which was fuelled by the school's teachers, is in storage. We were told that the World Bank project was given to the teachers at the school, but that anyone could collect water without charge. Money collected for its repair was stolen. We were told that people were not able to organise themselves to know what to do – they simply concluded, 'Na gov'ment own' and left it alone.[18]

Everyone who was interviewed acknowledged the need for a better source of water, and that water is a priority need. They believe that the solution to getting water is to get government funding for it.

## 5.4 Prioritising problems

In August 2010, a series of meetings was held at the school to keep the community informed of the SUNGAS team's activities and to get inputs into the assessments of needs and priorities.

18 'Na gov'ment own' is a common 'pidgen' English phrase meaning that something belongs to government, and is not the responsibility of the community.

Some meetings were well attended, with women outnumbering men. The leaders' 'high table' was comprised of men only. These leaders were helpful, and tried to be encouraging and positive about SUNGAS's agenda. The Chairman was tolerant and patient, and prompted people to come out and say what was on their minds. People were not overly willing to talk but were more forthcoming in smaller groups. Nevertheless, there was interest in SUNGAS and criticism of past development projects and organisations, the lack of community services, and the low number of community activities for the common good. This appeared to be an outcome of Aduku's tenants being tenants rather than landowners.

The community participants' perception at meetings was that SUNGAS was coming to Aduku to find out what people want, in order to get funding; so they had a shopping list. High on the list was a medical clinic. Women particularly noted that they are most affected by the lack of medical services. They said they would be willing to pay for them, since if they are sick, they can't farm and therefore can't generate income. Water was the next priority – they said they spend a lot of time collecting it and that it is not always good for drinking. They often walk two to three kilometres to fetch lake water; they would be willing to pay for water. Most people, however, did not relate poor water quality to illness. They feel they are 'used to' the local water and they claimed that diarrhoea is not a significant problem for their children. Malaria is their greatest health concern, and a few people reported occasional cholera outbreaks.

Water containers for Aduku classrooms © NDWC

Having confirmed that the community saw water as a priority need, we were able to suggest that SUNGAS start their work in Aduku to establish a functional water system. It was suggested that a more durable system than the World Bank one could be set up and that solar energy would be used to power the pumps. They were reminded that although there would be less cost to operating solar power (as fuel would not need to be purchased), there would be maintenance costs which they would have to bear. The community accepted the suggestion of building a water system, using solar energy to power it, and 'owning' the project as a community, thus contributing to its maintenance.

## 5.5 The abandoned World Bank water system

There was some suggestion of re-activating the World Bank water system in Aduku. The system included a nine-metre borehole powered by a three-kilo volt-ampere generator. It had a small tank on small beams that could not handle heavier loads. The value of project at construction was US$4000, but the contractor was not paid, so he left without completing it

to the standard in the design. We wondered why the World Bank put in such a small water system in Aduku – this was not their usual type of project. We were told that it was provided as part of a World Bank national education package that included teachers' quarters and a water system. It was sited in Aduku through the intervention of the Chief of Aduku, who was then a director in the Ministry of Education. Teachers made some efforts to repair the pump when it stopped working, but they were unsuccessful, and money collected for payment was stolen from the school.

The SUNGAS team considered installing a solar-powered pump, but the nine-metre depth of the well was not adequate to ensure water in the dry season; and when water was high, contaminated surface and near-surface groundwater could contaminate the water being pumped into the tanks. NDWC's SUNGAS team did not want to 'fiddle' with a system that had such a high possibility of being inadequate, in terms of quantity and quality of water. Although it would cost more than the SUNGAS budget allowed for demonstration projects, it was decided to establish a new site-specific solar-powered water system next to the World Bank system.

## 5.6 Design and construction

NDWC's SUNGAS team, the contractor for borehole drilling and civil engineering works, and the community counterparts met to discuss project design issues. In planning the design and construction of the solar-powered water system, many things had to be considered. Among them were:

1. **Water quality:** Aduku clearly has a high water table, but efficient recharge of ground water means that shallow wells are likely to have bacterial contamination. The only well in Aduku – the nine-metre well provided by the World Bank – had unacceptable levels of iron, indicating that good water would have to be located at a deeper level.
2. **Distribution**: From past experience NDWC knew that distribution systems are particularly vulnerable to both accidental damage and vandalism. They also knew that when water leaks continuously from pipes in an automatic solar system, damage to pumps is inevitable. The Aduku community is spread out linearly along a path with long distances between homes, and high trees obscure visibility between them; it would be impossible to safeguard pipes from vandalism here. NDWC's experience had shown that people do not mind carrying drinking water for short distances in buckets and jerry cans, as they can obtain the larger quantities required for domestic and agricultural uses from traditional water sources. As the school is at a central point in the village, reticulation was confined to the school compound, where it could be monitored from the school.
3. **Location**: The advantage of the site of the World Bank system was that it had already been accepted by the community as the location for a water system; land use and ownership issues should therefore be minimal. The area would be visible to the head teacher, providing some daytime security, while at the same time it should not disturb classroom or medical clinic activities. The location would not obstruct the path of any possible future building or road construction.
4. **System specifications**: A design was drafted using the most robust components available, taking into account the likelihood that tank capacity would need to be expanded. It was based on two plastic Geepee tanks of 5000 litres each. The stanchion was designed to allow for increasing the number of tanks in future. For security, an iron bar pump protector and simple but durable transparent fencing was included. The photovoltaic panels were to be mounted above the top tank.

By the end of March 2011, the contractor was mobilised on site. During the next few weeks, land-use issues were unexpectedly raised; there were demands from community members for payment for 'loss of use' of the land being used for the system. In response, two families were given US$32 each by the SUNGAS team.

Drilling then commenced. The first borehole reached 75 metres, but it collapsed and had to be abandoned. The second borehole was drilled to 90 metres; it was developed and cased, but the water was found to have an unacceptable level of iron. The third drilling stopped at 50 metres, where the soil characteristics were favourable and good water was found. The well was cased, and the DC pump was installed, tested and found to be adequate.

From June to August, the tower foundation was constructed, the tank stand assembled, the solar array installed, the tanks put in place and the fetching point constructed. While construction was being completed, water samples were taken to Port Harcourt and reported to be potable by WHO standards. The Vice Chairman reported that the water is very good for drinking and it is the best they have seen so far in their village.

Completed solar water system in Aduku © NDWC

The SUNGAS team and NDWC top management visited the site regularly to spur the contractor on.

There were recurrent delays due to both contractor and community neglecting their duties. Community members who had agreed to work and monitor the construction were not coming to the site. SUNGAS staff called a meeting of the members assigned, and they complained about how long construction was taking. SUNGAS staff explained that multiple wells had been drilled, and when a deep well was selected, it required a heavier stand, foundation and so on. Those present agreed to summon the others to resume work at the site. Several instances of vandalism of construction materials were reported. Aduku leaders and Aduku Community Development Committee (CDC) representatives visited the water system periodically. A small leak inside the system enclosure was reported to the SUNGAS Team by community members and repaired by NDWC.

Meanwhile, an NDDC solar-powered water system was under construction near the Chief's house – one of the 200 NDDC systems from the programme that also included Kaiama. The Chief had not mentioned this, despite being fully aware that it was planned. The system appeared to be about 90 metres deep, with a Lorenz pump. A treatment plant was also planned because the water had high levels of iron. NDWC staff predicted that this system would fail technically and in terms of its management and sustainability.

## 5.7 Energy use and needs survey by D-Lab team

The sustainable energy research group D-Lab visited Aduku in the first week of February 2011 (see also Section 4.4.3 above).

An IIED and D-Lab team made informal visits to Aduku to research energy usage in the village by circulating 'energy diaries'. The objective was to demonstrate the potential for solar lamps, and to consider the possibility of installing a solar-powered mini-grid in Aduku. The visitors were accompanied by the NDWC-SUNGAS team that was working on the solar system process.

Various people from compounds in Aduku, and others from across the river in Abari, took offence at not being informed or involved in this visit of 'strangers', and the Chief called a meeting to explain the visitors' mission. SUNGAS delivered a letter of explanation to the Chief. At the meeting the Chief, his deputy and others complained that the SUNGAS project was overstepping its bounds, working with people and carrying out activities that they had not approved in advance. The Chief said that as the overall head in Aduku he is expected to know all happenings in the village so that he can advise appropriately. He said he felt humiliated by his own people on several occasions when they asked him why the white people were visiting their land. When he replied he had no idea, they said he was lying. He insisted on clarification in order to defend himself.

We apologised for the delay in giving him our letter and further explained the reasons for the D-Lab/IIED visit. We gave him a copy of the energy diary and told him the essence of the workshop in Yenagoa, demonstrated the different solar lights and gave him one. We showed him photos of the workshop with D-Lab/IIED in Yenagoa. We also gave him a briefing about solar lighting, including a quality and cost comparison of the use of candles, kerosene and generator lighting. This was followed by a lively discussion of larger energy needs, durability of solar lamps and sources for purchasing them.

## 5.8 Planning for sustainability

The main focus of the SUNGAS renewable energy component was to demonstrate sustainable solar energy projects. We knew that SUNGAS's commitment to maintaining the water system would have to end within a year of completion, and to sustain the system, funds would be needed to pay for repairs and perhaps to operate and secure the site. We made every effort to consider all possibilities suggested to determine where those funds would come from and how they would be managed. It was a huge challenge.

Intuitively, it would seem that a community where such a useful development project was provided – which met an expressed priority need – would step up and take over its operation and maintenance. The community could surely implement a plan, designed by residents and based on their own resources and social structure. In reality, there is little community spirit and cohesiveness for working together on a long-term basis in a tenant community where tenants do not own land and cannot build their own permanent structures. There is also the reality that community service takes time and depends on people being able to afford to contribute time and/or money to activities for the common good. In many cases, the technical and management expertise is lacking, too limited or too expensive to be supported by the community. Most significant perhaps in the Niger Delta is the public belief that people have been exploited and are therefore entitled to free public services.

Throughout the period of the system's construction, people were encouraged to visit the site, and the school staff and students were kept informed of progress. However, the individuals assigned to work with us to represent the community showed only intermittent interest.

Planning for sustainability began well before the system was constructed, and once the water system was operational, sustainability took centre stage. We discussed the design of the solar-powered water system with the community representatives assigned to us. We explained the processes we would be following, both to construct the proposed system and to plan its sustainability. Over a two-year period – during construction and for some time afterwards, from February 2011 to February 2013 – the SUNGAS team made strenuous efforts to facilitate the evolution of an acceptable and implementable sustainability plan for the community's water system. The section below gives extracts from a diary recording those efforts.

**Planning sustainability: February 2011 to February 2013**

| FEBRUARY 2011 | |
|---|---|
| **WATER COMMITTEE FORMED**<br>**DISCUSSION ON CHARGING FOR WATER** | The Aduku Water Management Committee is set up with five members including chairman and secretary:<br>• Committee agrees on need to charge for water collected<br>• Agrees on need to define an operational plan e.g. to decide on charges for service<br>• Agrees to open bank savings account at Odi, the only bank in the area<br>• Agrees that security guard not needed as several teachers resident in the compound where water system sited.<br>A meeting with the Chief results in agreement that:<br>• Water can't be free; community charges would help sense of ownership, rather than seeing system as government's or NGO's.<br>• Sustainability plan now urgent as SUNGAS responsibility for project could end in six months.<br>• SUNGAS team suggest pay-in-advance coupon system to collect money, as used for cell phones and government electricity supply.<br>• Chief feels this would generate conflict.<br>• Chief suggests that community agree fixed amount per month (e.g. US$1.25 to US$1.90)<br>• Chief agrees to hold community meeting in March to discuss payment for water.<br>It is clear even at this early stage that Chief and community are unhappy about the need to collect money to sustain the system. |
| **MARCH 2011** | |
| **CONSTRUCTION BEGINS** | At a large meeting at the NDWC base in Yenagoa with the Chief, community members and full SUNGAS team:<br>• Participants recall that many projects in other communities have failed.<br>• Chief expresses doubt that the NDDC project would work, and criticises international interventions, but observes that he thinks the SUNGAS project will work.<br>• Director says that construction will now be mobilised.<br>• Chief promises three people from community to work on site.<br>• CDC chairman volunteers to visit site regularly.<br>Construction of the water system begins. |

| **APRIL 2011** | |
|---|---|
| **DISPUTES ARISE** | During construction:<br>• Two community members force work to stop; complain that they were not consulted about the project; and make land ownership claim.<br>• Elder settles dispute.<br>• SUNGAS make payment for purchase of land where borehole located.<br>• Work on the site resumes.<br>• Conflicts continue and community members assigned to work seldom turn up.<br>• CDC Chairman does not visit site at all. |
| **JULY 2011** | |
| **CHARGES FOR WATER: DISCUSSION CONTINUES** | Another meeting called by SUNGAS to convince people of need to collect money for water, or face inevitable breakdown of system:<br>• Participants reminded that Aduku's water system cannot be sustained without funds for:<br>– maintenance – cleaning of panels and tanks<br>– repair – tap gaskets, plumbing connections, eventually the pump<br>– labour and transport.<br>• SUNGAS asks, 'How will the community raise the money?'<br>• SUNGAS team will work with water committee for six months to develop a plan, then hand over system to committee<br>• Through participatory discussion about costs with SUNGAS solar expert, participants agree that US$5 per month (or US$3 per family) will raise enough money over five years, if only 15 of 100 families in community take part<br>• This would sustain the project and set example to other villages<br>• General willingness to pay agreed<br>• Various disagreements: How is a 'family' defined? What if people collect water but don't pay? Who will collect money?<br>• Agreed that payment tied to use of water, and funds kept in Aduku Solar Water Project account.<br>Weekly meetings continue between SUNGAS team and Aduku water committee and/or Chief and community. |

| | |
|---|---|
| **AUGUST 2011** | |
| **WATER SYSTEM OPERATIONAL** | Water distribution begins.<br>System operated automatically for testing, and its usage is monitored, to indicate potential for generating funds for a sustainability plan. |
| **SEPTEMBER 2011** | |
| **WATER COMMITTEE ESTABLISHED** | Aduku Water Committee formally established:<br>• Committee has five people from Aduku and two temporary members from SUNGAS team.<br>• Bank account opened in Odi, with one community signatory and one SUNGAS signatory.<br>• Record book issued to the committee.<br>• Water system confirmed working well.<br>• Committee members to collect monthly payments from families who collect water. |
| **OCTOBER 2011** | |
| **UNDER-PAYMENT FOR WATER** | This month only five of 100 families pay US$3 each for water; 30 families are reported to collect water; some use 'trucks'[19] to fetch it from far side of village. |
| **CDC LEADER ENGAGED** | Only the water management committee is permitted to operate the system's on/off switch from inside the enclosure; however system is being turned on and off by unauthorised community members.<br>A lock installed to ensure system only operated by committee members. A sign to be put on water system stating water only to be collected by those who pay for it.<br>A meeting is held with CDC leader of Aduku community at NDWC, Yenagoa, to build rapport and discuss sustainability: |
| **END OF FIRST YEAR REVIEW** | • CDC leader promises to support project's sustainability.<br>• He promises to insist in the National Executive Meeting (for Abari and Aduku residents) that all Aduku residents must use the water and pay US$0.60 to 1.30 per month.<br>• He reports that Aduku welcomes this NDWC development.<br>• He wants to see the project commissioned formally.<br>• NDWC want to see sustainability plan working for three months before commissioning – no point commissioning a project that collapses soon after the occasion. |

19 Two-wheeled farm carts.

| | |
|---|---|
| | At the annual project meeting held between NDWC, IIED and the other SUNGAS partners:<br>• Problem acknowledged of establishing plan for sustainable management of water system.<br>• Participants revisit logistical framework drafted in advance of construction.<br>• Noted that the period of project so far (and overall) is too short to get meaningful data to measure or verify outcomes and impacts.<br>• NDWC had however made correct 'negative critical assumptions', having anticipated the following potential risks:<br>– Aduku people might stop payment of water charges after NDWC's six-month commitment to management expired<br>– potential for vandalism<br>– potential for land disputes<br>– potential for mismanagement of funds among committee members<br>– potential lack of commitment to management activities by committee members<br>– potential problem of leadership not having authority to enforce agreements<br>– parents could worry about children's lack of security at the fetching point<br>– there could be increased strife among children and adults.<br>Clearly, much more needs to be done to identify and test sustainability options for the project. |
| **NOVEMBER 2011** | |
| **WATER DELIVERY AT RESTRICTED TIMES** | The SUNGAS team visits Aduku to see how collection of water rates progressing:<br>• Committee chairman reports US$32 collected by the person responsible.<br>• Funds not yet deposited in bank due to cost of transport to reach the bank branch in Odi: US$12 for a round trip by motorbike.<br>• Chairman concerned that many people collect water but do not pay.<br>• Suggests delivery of water is regulated (rather than automatic) between 6–8 a.m. and 5–8 p.m. with a key held by the water committee.<br>• SUNGAS team agrees to try plan. |

| | |
|---|---|
| | Five families pay for November; committee secretary gives funds to SUNGAS team to deposit.<br><br>Committee complains about woman living near water system, who claims to be a landlord; she refuses to pay, causing others to refuse as well.<br><br>SUNGAS team and water management committee fix sign on system stating that anyone who does not pay water rates should not collect water, from 1 December.<br><br>Subsequent committee meeting agrees 'no pay: no collecting water' policy to start in December. |
| **DECEMBER 2011** | |
| **UNDERUSE OF WATER SYSTEM IN DRY SEASON** | This month is the peak of the dry season so heavy use of water expected:<br>• Water system operated and managed by the committee.<br>• Collection monitored by SUNGAS morning and evening.<br>• On busiest day only seven families collect one to five containers of water each.<br>• In one week a total of only 15 families collect water.<br>• US$25 collected in December.<br><br>Members of the water management committee meet at NDWC office:<br>• Noted that payment not being enforced.<br>• People still break into system to turn on and off, instead of using the key (held by the water committee).<br>• Box installed around the switch to prevent this.<br>• Everyone agrees payment should be enforced.<br>• Most of SUNGAS team feel SUNGAS is too patient: Aduku should be forced to own and sustain it, or system shut down until sustainability plan in place.<br>• Others in team urge restraint. |
| **JAN 2012** | |
| | Only one person pays for water. |

| FEB 2012 | |
|---|---|
| **CONTINUED LOW WATER USAGE** | Water committee Chair says regulation of water is working in that people who do not pay are not collecting water, but usage is low.<br>Collecting funds:<br>• Some money collected is not deposited because the record book is misplaced.<br>• Chairman reminded it was supposed to be 'pay before fetching' but now it is 'fetch before paying'.<br>• No one pays for February.<br>• NDWC's SUNGAS team is disheartened.<br>• Water reported to be 'cloudy':<br>– SUNGAS team suspects this is due to lack of use; early rains mean readily available water from catchment containers.<br>– System flushed out, and water clears quickly.<br>SUNGAS team observes that committee members are leaving all the work to the Chairman; one teacher finally agrees to assist while at work.<br>Community members complain about timings:<br>• They want to fetch water but timings are not good for them.<br>• They can't pay for water if system is locked when they need it.<br>• Most families have stopped paying because the system is often locked – some weeks the system is only opened on three days. |
| **MARCH 2012** | |
| **SUSTAINABILITY PLAN ABANDONED** | Visits by SUNGAS team to water management committee reveal that sustainability plan is abandoned:<br>• Committee members ask for time to persuade community to resume payment.<br>• SUNGAS team repeats it will pull out of project if problems not solved.<br>• SUNGAS team suggests commercialising project; giving to a private individual to operate. Given the social issues, however, it would be hard to find an operator acceptable to all stakeholders. |

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| | The Chairman told us that:<br>• He alone on the committee has done all the work.<br>• Low water use continues.<br>• People complain that US$2.84 too much to pay, despite agreeing to the amount earlier. People are willing to pay US$0.10 for a sachet of water, but not the same amount per day for a whole jerry can of SUNGAS water.<br>• People say they will not pay in advance, but will contribute if system breaks down. However, how many paid when the World Bank system broke down?<br>• A committee member was slapped when trying to collect money from a water user; she will now not work with the committee. |
| **APRIL 2012** | |
| **CHIEF IMPOSES WATER CHARGE** | A meeting is called by the Chief for the SUNGAS team, water management committee and community members:<br>• The Chief declares that all tenants of Aduku to pay US$0.63 per month – whether living near or far from the system and whether or not they use the water.<br>• All funds generated to sustain the Aduku solar water project.<br>• Any defaulter to be reported to the Chief and disciplined. |
| **MAY 2012** | |
| **CHIEF TO ADD CHARGE TO TENEMENT RATE** | Virtually no payments made this month to committee or Chief's representatives.<br>• Chief promises to include a fee for water in the annual tenement rate paid by Aduku tenants to the National Executive Committee.<br>• Rates collected annually in October; this October a US$6 water rate will be added to existing rates.<br>• All stakeholders agree. |
| **JULY 2012** | |
| **FLOODS** | There is a natural disaster throughout the Niger Delta: unusually heavy rains followed by unprecedented flooding. Most livelihood activities in the community destroyed. |

| OCTOBER TO DECEMBER 2012 | |
|---|---|
| **FLOODS** | Floods – no access to community. School compound flooded; school closed. Some water collected as system functions but most people have left the town. The tenement rate cannot be collected as planned in October. |
| **JANUARY 2013** | |
| **WATER USE UNREGULATED** | The Aduku people are planting new crops and establishing new farms. People must generate enough economic activities to enable them to pay the taxes that were to have been collected by the Chief in October.<br>The water system is working and use is unregulated. |
| **MARCH 2013** | |
| **NO RATES PAID** | No rates have been collected.<br>NDWC discover that only one tap is working, and repair the system. Weekly monitoring since that time shows that the use of water is still low as the rains are increasing. |

**Box 5. Water use by school children**

Shortly after the water system was installed, the SUNGAS team found that the school pupils were not using the jerry cans provided for water – these were locked up in the head teacher's office. Instead, they were drinking water directly from the tap.

As children are generally rough with the distribution facilities, and it was felt that it would be disruptive to have children leaving their classrooms to use the taps, we decided to put jerry cans fitted with taps into the classrooms, to be filled by an assigned person each day. Children could collect water into personal cups. A jerry can stand was constructed and taps purchased for the 25-litre jerry cans in each classroom. Students and teachers participated in an assembly explaining how the jerry cans would be used and how the solar water system worked; this was an opportunity to train children to be change-agents.

There was enthusiasm about the innovation and it was working on our visits during the next few weeks; however, children were sharing one cup per classroom. SUNGAS was concerned about the possibility of spreading infections, and decided to look into buying individual cups.

However, we were told a few months later that after the holidays, the jerry cans were kept in the school store and no longer used. Students were drinking direct from the taps and washing their feet in the running water.

## 5.9 Lessons learnt from the Aduku project

The experience with the Aduku solar-powered water system has been a good one with respect to the technical design and providing an effective water service to the community. It has been disappointing with respect to community buy-in and taking responsibility for sustaining the system.

### *5.9.1 The role of a water management committee*

A water management committee has not been effective in Aduku. This is due to the fact that the mixture of tenants and landowners among residents creates conflict over rights and the authority to collect water rates. Furthermore, although it is clear that community members are industrious multi-taskers, it cannot be expected that even a few of them will be able to make the necessary sacrifices for carrying out the responsibilities of water management freely and for the common good. Committee work is thankless and there is huge resistance to paying for water, especially when it is seen to the responsibility of 'government', 'donors' or 'NGOs'. People say that in nearby villages residents are not charged for water, and that since even though it is true that 90 per cent of the 'free' water systems are not functional, they should not have to pay for their functioning one, either.

It has become clear to NDWC's SUNGAS team that, with few exceptions, community water management committees cannot be expected to take full responsibility for organising themselves or the public to manage and sustain water or energy systems. These utilities require huge initial investments and substantial funds both for security and technical troubleshooting, maintenance and repair – even for small and cost-effective designs.

A water management committee could be effective and feasible if members are only expected to have occasional meetings and limited responsibilities, which might include:

- awareness-building of best practices in using their water systems within the community
- being the reporting point for system malfunction
- having information on where to get technical assistance
- sanctioning people in their community who misuse or vandalise a water system, through local agencies responsible for social regulation
- working with their chiefs, elders and others willing to be involved (such as wealthy individuals or NGOs) to influence the release of government or other sources of funds; or for getting them to take direct responsibility for security and sourcing technical capacity for system maintenance.

### *5.9.2 Seasonal variation in water needs – and floods*

In Aduku and other communities we have worked with on solar water projects, people tend to collect water from the nearest and most convenient point possible. Thus during the rainy season there is readily available water in streams and rivers and lakes, and people can usually collect enough potable water in rainwater catchment containers. It is only when streams and wells dry up and rivers banks are exposed during the dry season that people will go to private boreholes – particularly if they are free. This problem of seasonally variable demand and competition with other sources of water during the rainy season minimises any willingness to pay for potable water, even if it is recognised as being of better quality.

During the heavy floods in late 2012, water in rivers and streams was heavily contaminated; in most villages that are usually dry, canoes were required to move from building to building. Water was knee high around the Aduku solar water system, but clean water was gratefully collected from the taps.

### *5.9.3 Future sustainability*

The Aduku SUNGAS solar-powered water system could be sustained if funds are sourced for a management system, including a person paid to manually turn the overall system on and off at specified times, to monitor and troubleshoot, and to report faults when they arise to someone with the capacity to do the repairs. A self-service system is not recommended because of likely recurrent damage to taps (and thus to pumps) by the large number of children in the school where the system is located.

Under the land tenancy arrangement in Aduku, the water system will have to be the direct responsibility of the Chief of the landlord community. He has the authority to source funds from the community through the traditional annual taxation system which is already in place, from the local government area chairman, from community development committee funds or from discretionary funds given to his post as Chief. If the Chief succeeds in finding adequate funds, there is no reason why the robust and appropriately sized Aduku solar-powered water system could not satisfy the Aduku people's need for potable water for many years.

# 6
# Pilot projects in Odi and Bomoundi

The second NDWC-SUNGAS pilot was sited at Odi, a town on the River Nun, five kilometres from the East-West Road in Bayelsa State, and the closest major settlement to Aduku. This section also describes a contract NDWC had the opportunity to carry out during the time of the SUNGAS project – a water system for the Shell Petroleum Development Company (SPDC) in Bomoundi.

## 6.1 The Odi pilot project

The project in Odi was intended to demonstrate a development project operated as a franchise under private ownership; the design included a relatively shallow well with a treatment plant in order to reduce the cost of a rig-drilled well.

The experience of the Aduku community solar-powered water system project taught us that a volunteer community committee operating a shared utility was going to be difficult to achieve and sustain over time. Indeed, the few successful long-term water systems we had seen elsewhere in the Delta were those owned and operated by individuals, for their own use, and for those who collected or purchased water under the owner's supervision and discretion. There are very few people with this benevolent attitude and enough money, especially in remote areas. However, a system which is managed by an individual has inbuilt incentives to ensuring sustainability; it is in the manager's financial interests to keep the system functioning.

We decided that a water system could be set up and franchised to an individual, with full responsibility for operation and maintenance, who would generate income in proportion to their efforts. The initial goal would not be to recoup the owner's investment, but simply to see if the system could be sustained and generate some income through operating as a franchisee.

### *6.1.1 Assessment of Odi*

Odi is a much larger town than Aduku with numerous private boreholes, and some owners sell water collected in jerry cans. Our preliminary investigations of the availability of potable water in Odi indicated that there was a shortage of potable water in many parts of the town (most water has iron) and that there were people willing to purchase such water when it was available. Discussions with people throughout Odi confirmed that very few borehole water systems delivered potable water, and that people would pay for drinking water if the price were right (about US$0.05 per 25-litre jerry can).

In August 2011, the SUNGAS team and the NDWC management visited Odi to assess its water sources, services and needs. We visited owners of three of the numerous small water systems that use diesel generator-powered pumps, where water is used privately or sold; all of this water had iron present in it. Owners claimed they could generate US$19 a day when water was in demand.

Many people in Odi said they used river water for everything except drinking; for drinking, they treated their river water with alum or bought sachets of 'pure' water. Most families have catchment tanks or drums for collecting rainwater for drinking in the rainy season. However, the general consensus was that if a water system provided water that did not need

treatment with alum at a reasonable price, it would get a lot of business.

A solar water system supplied by UNICEF at the Health Centre in Odi worked for some months until the batteries in the system stopped working. Odi also has a large diesel generator that would be capable of pumping water from all the boreholes if it were working; however it is only operated when someone from outside the town comes for a function and buys fuel to power it.

We began to look for an individual who might be able to operate the franchise. We identified an entrepreneurial woman with her own home and enough space around it to construct a water system. It was important to find someone with an existing stream of income to ensure that they would not have to dip into 'company funds' for survival when the water business was not generating funds. This individual met that criterion, as she had a part-time job as a cleaner in the local secondary school and also a farm from which she harvested food for sale and for her own use.

### *6.1.2 Design and construction*

One SUNGAS project objective was to establish projects that are 'replicable' by local people, either without inputs from outside parties, or which generated enough income so that outside investors would have an incentive to invest in them. We therefore discussed ways to reduce the cost of the physical components of the water system.

There is a lot of talk among water services providers about filtering water from shallow wells,[20] as these wells are significantly less expensive to construct in typical off-road riverine areas than rig-drilled boreholes. Various organisations have set up demonstrations of these treatment systems for removing iron from the water. They have included sophisticated commercial ultra-violet and carbon filters (for instance by USAID and UNESCO) and Geepee tanks with sand and charcoal filters (such as by oil companies and NDDC). An oil company in the Niger Delta recently demonstrated table-top filters for the home, in which water is cleaned by filtering through sand and bacteria; others report successful use of a moringa seed slurry instead of bacteria. We designed a solar water system much like the successful Aduku water system, but with a shallower well and the addition of an aeration (flocculation) tank and two Geepee tank sand and charcoal filters. These filters are inserted into the water collection line before the delivery reservoir tank. No power source is needed to filter the water; it passes through the filters by gravity.

The borehole in Odi was completed in mid-October and soil samples were gathered at approximately every three metres. It was determined that acceptably potable water could be extracted at about 35 metres, although suspended iron particles are still present, and the borehole was cased to this depth. We then added the filter system, having seen and approved the method demonstrated in our laboratory by our contractor.

This system was not particularly complicated to construct, but delays were caused when the contractor absconded (not an unusual occurrence; see our comments on Boumondi below) and then there was the unprecedented flooding in late 2012. This came before the plumbing was complete and the pump connected. Once the floods had receded and canoes were no longer needed to move around the site of the water system, water from the borehole was pumped through the sand and charcoal media of the filters for several days until it was clarified and acceptable for drinking. Finally the water receded and a security wall and fetching point with three taps were constructed.

Unfortunately, the heavy rains had not only made the system inaccessible but had also provided excess rainwater for storage in catchments

20 75 metres and less.

containers (common outside Odi homes) resulting in minimal water purchases.

By April 2013, the Odi system had demonstrated its operational capacity. Flushing water through the filter media was effective and it is now clean.

### *6.1.3 Planning for sustainability*

We expected to develop a sustainability plan in which the manager, or franchisee, collected payments for water and put a percentage of the payments into a fund to be used to sustain the system's operation. This might even possibly provide some return to a potential sponsor or franchisor wishing to replicate this model. We believed that if the water were of better quality than water sold by others, there would be a demand for it. However, we needed to consider innovative marketing and pricing systems, to avoid appearing to steal the market from the other water sellers (which could result in sabotage).

With the water system functioning well, the NDWC team took up the sustainability plan discussion again with its manager. The team reaffirmed that the solar water system is not a free gift from NDWC or SUNGAS. It is rather a project through which someone outside finances the establishment of a water system, then allows it to be operated without further financial assistance. The manager is expected to manage the system, make repairs, and collect money from the water purchased. She is to keep a daily record of sales; duplicate records are to be kept and checked weekly by both the manager and the sponsor.

### *6.1.4 Manager's concerns*

The manager reminded us that water demand depends on rainfall. When it rains, the demand for water is low, because people's catchment containers fill up. She also said that even though people occasionally come from distant parts of Odi because her water has a reputation for being the 'best in town', she has had to drop the price. She originally sold the water at US$0.13 for a 25-litre jerry can (which is the same price as in Yenagoa) but she has had to decrease this to US$0.06 to compete with others selling inferior water.

She said that she does not always stay at home so she suggested paying a salary to somebody to sell the water for her. It would clearly not be cost-effective to pay someone when the volume of sales are unknown. Instead, the owner could set times for selling water in the morning and evening when people normally collect water for the day. It was agreed that the water could be turned on when the owner is around and it can be turned off when no one is around.

### *6.1.5 Low water demand*

The sale of water began in February, and because it was the end of the dry season, people collected 'the best water in town' both in jerry-cans and in private 'trucks' (two-wheeled farm carts). For the month of February, sales exceeded US$95; the owner paid 60 per cent of the amount to a SUNGAS franchise account, which was held by NDWC, as the only bank in town had not re-opened after the flood forced its closure. The next month, income was US$50; the next, US$45. Rains will continue at least through September, and in recent years the 'dry season' from November to March has not been very dry. Hope is waning of making adequate payments into the account to prepare for inevitable repairs and to replace the filter materials every 6-9 months.

It is clear that the predicted high usage rate of potable water has not happened. The main reason appears to be the overabundance of rainwater this year. There are parts of Odi where there are fewer sources of borehole water, and the owner is considering the construction of a cart to carry water to those areas. However, this will require further investment and the employment of a cart-pusher, and is not likely to generate enough additional income for the manager or the franchise account to compensate for the costs.

### 6.1.6 Outcome and future sustainability

Soon after water distribution started, the manager reported two broken taps via cell phone to the SUNGAS team. When the SUNGAS representative arrived at Odi for his weekly visit, he found that the two taps had been repaired. The manager had taken funds from her sales to replace the broken ones. The SUNGAS representative spent an hour and a half monitoring water collection and noted that mainly the old and young fetch water; most come with buckets, and a few with 30-litre containers that they transport in wheelbarrows.

The manager's genuine interest in sustaining this water system, and the fact that its water continues to be 'the best in town', bodes well for future demand. However, the SUNGAS team is concerned that the income generated may not be enough to cover ongoing maintenance costs such as replacing the filtration media periodically, and repairing taps and plumbing.

## 6.2 Shell Petroleum Development Company project in Bomoundi

As noted above, one of the key objectives of SUNGAS is to stimulate replication of experience and lessons learned in the course of implementing the demonstration projects. In early 2011 Shell Petroleum Development Company (SPDC) offered NDWC a contract for one of several solar-powered water systems designed by SPDC consultants for one of its major production areas. NDWC expressed interest because of the solar power component, seeing this as an opportunity to pilot a solar powered water treatment plant.

### 6.2.1 Design

When we saw the design, we knew from experience that it had inherent technical inefficiencies and complexities that would cause the systems to fail. There was a solar system supporting the pumps in the boreholes, and another solar system with batteries and an inverter to pump water horizontally through sand and gravel filters as well as vertically through a charcoal filter. Delivery of water from the system was manual, requiring a trained individual to manage it and open the controls supplying the public taps. Our concerns were about the complexity and expense of having two solar systems instead of one, as well as a treatment plant; and the manual operation of the pump.

After our experience with NDDC, we were not hopeful that a change in design would be approved for a contract that had already been awarded. However, we pushed for a meeting with SPDC and its consultants, including the designer of the system plan, and were pleased that they agreed to hear us out. We explained our concerns and described our experience of systems supplying similar amounts of water. We recommended ensuring that the borehole:

1. is deep enough not to dry up in droughts
2. collects water from a level at which no iron is present.

Both considerations require a deep borehole (generally 135 to 300 metres) and a substantial rig, unlike the shallower wells (less than 75 metres) that are commonly dug manually. We noted that our proposed system would not require the structural complexity of a treatment plant with an expensive second solar system to support it, or the cost and labour required to periodically recharge the treatment materials. We also noted that their system would require manual operation, unlike our automatic design: the reservoir fills during the day and a simple float valve switch turns off the pump when the tank is full. To our surprise, SPDC agreed to let us re-design their system, with the proviso that we not ask for increased funds to implement it.

### 6.2.2 Bomoundi-Ekpetiama

Bomoundi-Ekpetiama is in Bayelsa State, accessed by the Tombia-Yenagoa Road near the SPDC gas facilities. To reach Bomoundi, canoes with outboard motors must be hired to cross the Nun River. All construction materials and equipment (including rigs and steel

stanchion parts) must be carried down a river bank on the opposite side of the river and loaded onto the boats, then unloaded by carrying them up a steeper river bank, provided with concrete steps, on the Bomoundi side. Local labour must be hired for carrying. Once goods and equipment are carried up the river bank, they are moved to site manually (our site was about 1.5 kilometres from the jetty).

### *6.2.3 Challenges to implementation*

Several challenges arose as we implemented the project, which increased our costs and the time taken to complete it. We mention a few below; they are good illustrations of why projects are often abandoned or fail.

**Contractors disappoint**
Contractors are capricious, commonly disappearing to do work on other projects (to which they divert funds), delaying the work of their artisans and others dependent on them. Their lack of site supervision often results in careless work – in this case a tank fell off the stand, and poor quality materials were used for borehole stabilisation and for the tank support grids, which then had to be replaced. Rig owners often disappoint the contractors, or do not have rigs that can be moved by outboard engine canoes across a river and up a river bank, or they have such rigs but they are not available when scheduled, and so on.

**Contract requirements create unforeseen difficulties**
We were advised to put our new system at the site of an existing system. After three unsuccessful attempts at locating good water at that site, we had to change to another site, and were required by the community to return the old site to the condition it was in before we started work. This meant more costs and delays.

The SPDC's specifications for the size and composition of the reservoir tanks and distribution pipes meant that they were obtained with difficulty, requiring special orders to be placed with specified manufacturers. When it was not possible to obtain an identical replacement tank for the damaged one, we obtained approval for a tank that had the same internal volume but was shorter and wider. The larger diameter left less room on the platform for movement around the tank for cleaning, pipe leakage repairs and so on; this was dangerous to workers. As a result, the platform had to be enlarged at significant expense.

**Flooding**
As in other parts of the Delta, heavy rainfall and flooding made transport and work at site difficult.

**Local youth to supply unskilled labour**
While using local labour and providing employment for 'indigenes' is consistent with empowering communities (and is indeed a requirement of sponsors), the young men from Bomoundi (up to 100 at a time) formed an organised, often threatening, labour group, insisting on rates for digging trenches, placing pipes and so on that were up to five times what is normally charged in the townships. Even with patient negotiations, the price remained high; our best bet was to be sure there were no delays caused by a lack of agreement on cost or materials, so that once work started, it was finished quickly. We identified a few community members who worked as our representatives and who also ensured that we understood the workers' demands.

**Extent of distribution system**
The specified distribution system was far more extensive than we felt comfortable with – 1.4 kilometres – considering our experiences with other systems in the region, where vandalism was the rule rather than the exception. However, the community insisted that we fully implement the design, so we spent a lot of time explaining that if the distribution system was damaged, the pumps could be damaged, and the whole system would no longer work. One of the community representatives working with us was appointed as a 'troubleshooter' to turn off the system and report to us if there was any fault. A

few leaks were repaired, and a float valve had to be adjusted, which proved the efficacy of our reporting system. Time will tell if this village can prevent damage to pipes and taps; and whether, if such damage does occur, they will be reported in a timely manner to SPDC; and whether or not SPDC will respond. NDWC has recommended that SPDC put a sustainability plan in place, providing a way to access funds or personnel for a quick response.

### *6.2.4 Project completion*

The contract for the project was signed in February 2012 and the project was completed in March 2013, when it was approved by the SPDC consultants who had monitored the entire process on a near-daily basis. It is simple in design, but robust, incorporating some higher-quality-than-specified components; this includes the pumps and photovoltaic panels, the stanchion foundation and girders, which were constructed to enable them stand up to the annual rains and floods, and the plumbing and connections were also of a higher standards than required. We felt this was necessary, based on lessons learned from the water systems we have constructed.

Information from various sources indicates that SPDC is impressed with the results of this automatic system; we hear that they are recommending our design for their future solar water systems.

### *6.2.5 Post-commissioning visit to Bomoundi*

In April 2013, NDWC staff went to Bomoundi and walked through all the reticulations points; the taps were all intact, and the community members appreciated the water that has been given to them, thanking NDWC for what they called a 'rare privilege' for their community. The Chief of Bomoundi is very happy with the water system; he says that the other SPDC solar water systems, which kept the original treatment plant design, are not working.

The Chief has accepted the usual 'community honorarium' from our contract, and agrees that it must be used as a sustainability fund, as there is no other plan in place yet for repairs and maintenance. The state government intermediary between SPDC and the community also received a required honorarium, but it is not yet known how this will be spent. The town's elite would like water piped to their homes, but they were reminded that the system is designed to provide drinking water only – and to serve everyone in the town. If the water were piped to their homes, it would be used for many other purposes and there would not be enough water for everyone to drink. (That said, the Chief has connected a hose from a tap to his house.)

Water collection point in Boumondi solar water system © NDWC

### 6.2.6 SPDC's other solar water systems

As we were completing our automatic solar water system in Bomoundi, we visited some sites where systems had been installed more quickly than ours and completed eight months earlier, using the original SPDC solar-powered pumping and treatment plant design. The ones we visited were found to be unsatisfactory, with people reporting that water was supplied irregularly and often not for weeks at a time. People from one of these sites, at Ekpetiama, visited Bomoundi and saw NDWC's system working well. They asked, 'Why? Isn't one solar water system as good as another?'

### 6.2.7 Future sustainability of the project

From the time SPDC took over the completed project and made the last payment to us, our local contact person continued to keep us informed of the water system's good performance. We paid him for this service for only three months, but he continues to stay in touch (three months later at time of writing). Significantly, because of our concern for sustainability, SPDC has verbally agreed to give NDWC a contract for maintenance and repair of any systems they constructed in the future. We hope the recommendation will be implemented.

We believe that the Bomoundi solar-powered water system will be sustained for the following reasons:

- Its design is simple; except for the pump, there are no moving (mechanical) parts, so it should have minimal need for repairs.
- The community has been warned that the weakest point in the technical components is the reticulation; and that while the pipes are sturdy and laid deep, they are still vulnerable to vandalism. Because the community made a strong case for the extensive distribution, against the advice of NDWC who warned them that broken pipes can lead to a damaged pump, we believe they will make an effort to protect the pipes.
- The Chief has accepted that the community's share in the substantial amount included in SPDC contract for payment to the community is to be used to monitor and make routine repairs to the water system.
- If SPDC follows up on its agreement with NDWC, they will arrange for a system to monitor and maintain the systems they construct. This will demonstrate better corporate practice and support the long-term sustainability of their projects, as well as improve company-community relations.

# 7
# Lessons learned from NDWC's solar energy programme

This section presents our conclusions about the prospects of sustainable solar-powered water systems in the Niger Delta, based on NDWC's experiences with the SUNGAS project. This paper is not a 'how to' guide or a toolkit for 'replicating' a project; we have repeatedly found that development work must be site-specific rather than replicated. However, there is value in looking back at both positive and negative experience and drawing out the lessons we have learned. Hopefully, these lessons can help others carrying out similar projects to bypass some of the challenges we met with; especially in Nigeria's Niger Delta.

Having completed the NDDC projects, the SUNGAS pilot projects, and the SPDC project, NDWC was in a position to step back and take a holistic view of the challenges of implementing solar-powered projects in the Niger Delta, and with working with a range of sponsors. We saw three main types of challenge for development projects and their implementation, whether for water systems, ICT, or biotechnology projects:

1. getting the technical aspects right
2. meeting the social and economic challenges realistically
3. understanding sponsor and partner relationships with local NGOs.

## 7.1 NDWC's observations and experience

In 1999, NDWC identified solar energy as the most promising energy solution for 'small home power', communication, and potable water in the rural areas of the Niger Delta. We established a renewable energy technologies programme, focusing on solar energy. We undertook studies of how solar energy could best be used for development activities, especially its applications to potable water delivery for remote riverine communities. We built awareness among the general public and professionals in development programmes, and provided training in the design and implementation of technically robust and efficient solar-powered water systems. We carried out private, grant-funded and agency-contracted solar-powered water systems.

In the implementation of all of our solar-powered water systems, we met with technical and socio-economic management challenges. Most project grants and contracts focus on the delivery of a defined product, and give minimal attention to the need for flexibility in time; design and materials used; site-specific adaptations; and the social issues that characterise the area where a project is to be carried out, in order that the project meets beneficiaries' needs. Very few sponsors allow budget lines to ensure that the service providers are able to meet the high costs of working in the Niger Delta; or the substantial costs of establishing a presence in the community; or of involving committed local people during construction; or educating reliable persons to manage, monitor and troubleshoot projects post-commissioning; or building awareness among the general public of how their project can be sustained.

The EU sponsored SUNGAS project was seen by NDWC as an opportunity to understand and demonstrate technical best practices and 'community participation' processes, based on

conclusions drawn from previous surveys and projects. It was believed that there was a very real opportunity to exploit synergies between SUNGAS objectives and NDWC's other projects of this type.

## 7.2 Technical sustainability of solar-powered water systems

As NDWC carried out site visits and reviewed project reports, we observed that the high failure rates of solar-powered energy systems in Nigeria were often due to technical problems in design and implementation.

If our proposed solar-powered water pumping systems were to function efficiently and be sustainable, we needed to know what technical specifications would best meet the needs of the environmental, economic and social capacities of our target rural communities in the Niger Delta. We needed to know where to purchase equipment and that maintenance and replacement parts would be available. We needed to have contractors with the technical skills required and access to equipment that could be taken to riverine areas. None of these needs were easily met.

Some of the main technical challenges we met and how we addressed them are described here. Needless to say, challenges and solutions vary according to project objectives and location.

### *7.2.1 General project design*

Sponsors who commission technical development projects increasingly insist on fixed project designs and specify the materials, parts, labour and costs to the contractors and NGOs who are implementing the project. Often sponsors of projects using new technologies, such as solar energy, recruit inexperienced consultants or academics to design the system. The resulting designs may be inappropriately sized, overly complex or unwarranted for their purpose, and are rarely tested as pilot projects.

Implementers need to be cautious when sponsors propose upgrading failed water systems such as manual pumps to solar power, or siting a borehole in inaccessible swamp or clay locations.[21] In one project that we carried out for SPDC, we didn't like the specified site in the village assigned to us; but SPDC insisted that we use it. When the drilling failed at that site, we moved at great expense to a site of our own choosing. The same project design included a complex treatment plant that we knew would fail. After we approached SPDC about this, they agreed that we leave out the plant and adjust the project design; the resulting project design succeeded. We learnt not to take anything for granted, and not to agree to do something that we know is likely to fail.

Although there is a widely held belief that there is not enough sunlight to power solar systems, our experience has shown that there is almost always enough sun to pump water, even on cloudy days. In order to ensure that water is pumped – even on rainy days – a lack of sunlight can be easily compensated for by building additional panels or larger pumps into the design. This principle can of course also be applied to other solar energy applications.

### *7.2.2 Setting the objectives of water projects*

Sponsors generally assume that their water system will provide water for multiple purposes. Wealthy people in a town often expect that the water will be piped to sanitary facilities and showers in their homes. However, a system large enough to provide water in homes for all purposes is not practical in rural areas where communities are discrete and scattered. People in the Niger Delta have many sources of conveniently located water for all purposes but drinking, and we have found that most have

21 However, the replacement of manual pumps by solar pumps for shallow wells has sometimes worked well where the water was good quality.

no objection to carrying potable water short distances from a pump to home. Even in Kaiama where the originally extensive reticulation system was reduced to one site near the tower, there was no complaint. The decision to provide water to be used mainly for drinking, with minimal reticulation, has hugely positive implications for designing efficient and cost-effective solar-powered water systems.

### *7.2.3 Boreholes*

**Siting boreholes**
Sponsors and communities usually insist on determining the site of a water system in a village. However, their chosen site may not be suitable from a technical point of view – for instance, prone to flooding, near a sink-hole, the likely site of future road or building development, or where water is known to contain iron. Site selection can then become contentious and delay project implementation. Implementers need to ensure that the selected site's characteristics will promote the system's objectives. Putting in a deep foundation and drilling a well in the wrong location may mean having to move site or leave a failed project behind, both of which waste time and money.

**Depth of boreholes and water quality**
Because the Niger Delta's aquifers have heavy iron contamination in places and at depths that are unpredictable, there are three main ways to deliver potable water:

1. Treat water from any aquifer or surface water to remove iron and other contaminants.
2. Drill multiple shallow to mid-depth boreholes (9 to 135 metres) until an aquifer of suitable water quality is found.
3. Drill a deep well (135 to 300 metres or more), which will deliver potable water in virtually all cases.

The vast majority of boreholes drilled in the Niger Delta are shallow to mid depth (9 to 135 metres). These can be drilled manually or with generator-powered motorised drills or rigs. Manual drilling has the advantage that equipment is inexpensive to own or hire and does not require expensive skilled labour; however, it is not possible to manually drill beyond 75 metres. Pump placement must be taken into consideration. Shallower wells have the additional disadvantage that during particularly dry years, the water table may drop below the level of the pump, which damages it; these pumps are not designed to function without water.

Small to large rigs can be used for mid-depth or deep boreholes. However, they are expensive to hire and owners are resistant to taking them by barge to remote riverine locations where they must often be moved up steep riverbanks and along trails using hoists and vehicles brought in for the purpose.[22] So-called 'electric' rigs are also available that are lighter and more easily moved to remote sites; the problem is that they cannot be used to drill beyond 135 metres.

Even when drilling a mid-depth well, it is often necessary to drill several wells before a good one can be established. Good water may not be located in the first or second one; the chemicals use to stabilise the walls of the well may be inadequate or of poor quality; or the walls of the well may collapse where they are made of clay or sand. With each failed attempt, casing pipes, chemicals and time are lost – at great expense.

The approach most likely to succeed in delivering potable water from a borehole in the Niger Delta is to design the project around a deep well of 260 to 300 metres, drilled using a large rig. However, the financial costs and security risks are substantial.

22 We saw an abandoned solar water system in a coastal village in Delta State during an SLA we carried out for a major oil company in 2004. The rig the contractor hired to drill the well had sunk at the site a year earlier. A huge amount of money was lost, both by the owner of the rig and the contractor carrying out the project.

### *7.2.4 Components of solar-powered water systems*

**Tower construction and tanks**
For some reason, sponsors like tanks to be very high; specifications commonly require 15-metre supports! However, the gravity needed to provide adequate distribution pressure – such as for outdoor taps or one-storey buildings – does not take much height. In fact, there will be less waste when water runs slower. A higher tower also requires larger pumps and thus more panels, increasing the cost.

**Batteries**
If the number of panels corresponds correctly to the number and size of pumps, and they are technically compatible, water will fill the reservoir sufficiently during the day – making batteries unnecessary. A battery bank in any type of solar energy system requires conscientious managing for batteries to function optimally – if the batteries are allowed to drain regularly their lifetime is reduced; if a few of the batteries fail for any reason, the functionality of the remaining batteries is compromised. Batteries simply add more cost and management complexity to a system, without bringing any greater benefit than allowing a few more panels and a larger pump can.

***Sourcing solar components***

The major specialised components in solar-powered water systems are the photovoltaic (PV) panels and the DC pump. There is a confusing number of brands and suppliers in Nigeria as elsewhere, but we have learnt to invest in the best quality components. Good panels such as Kyocera should last 20 years; large stainless steel pumps, like Grundfos or Lorenz, should last 10 or more years. The brands we prefer are not often available locally so we have resorted to importing them; a complicated bureaucratic procedure fraught with delays, but worthwhile, as we have not had any technical problems with imported items.

Other water systems components include float valves and charge controllers with cut-off protection, and lightening arrestors. These can sometimes be included in orders for imported panels and pumps, or sourced in Lagos, Abuja or Port Harcourt. We also buy sealed enclosures for all charge controllers after insect secretions in a charge controller once caused a short in wiring.

**Water treatment plants**
Whether treating surface or ground water, treatment systems are expensive to maintain. They require funds for regular management and to replace the filtration media. We have seen large filtration systems for river water (NDDC); small vertical treatment systems for shallow to medium-depth borehole systems (UNESCO); large, complex horizontal treatment systems (Bayelsa State Water Board) and smaller ones (SPDC). None of them works as designed, or to the satisfaction over time of the intended beneficiaries. They are just too expensive and labour intensive for rural areas – or even urban areas – to sustain.

**Water distribution lines and control valves**
Water systems' distribution pipes and collection points are particularly vulnerable to damage and vandalism. Wilful damage can be caused by competitors in the water market, and accidental damage by the careless construction of roads, buildings and farms, and by playful, unruly children.

Project design can build in features to make the system less vulnerable, including the use of above-standard heavy gauge pipes, laying the pipes deeper than required, and installing valves to enable turning one section of the system off while other sections can continue to function. From repeated experiences, however, we know that the best way to minimise such failure is to keep the distance the water is distributed short and to keep the collection points within viewing distance of the rest of the system, and/or to have someone responsible for monitoring it.

In cases where a community insists on extensive distribution, and knows that it will lose the extended reticulation if it fails, they may take better care of it. This appears to be the case with our SPDC system in Bomoundi (see Section 6.2.3).

**Faucet valves and tap heads**
As part of its efforts toward technological sustainability, NDWC imported self-regulating faucet valves and 'press down and hold' tap heads that shut off the flow of water as soon as the user releases it. This was to help conserve water and to ensure that careless users don't drain the tank unnecessarily by leaving the tap on; the resulting continuous uncontrolled pumping would risk damaging the pump.

However, no matter what sophisticated technology is used, taps are invariably handled roughly at public fetching points. For example, the taps that were meant to be pressed down and held for water collection were pressed up and sideways – in spite of the instructions and directional signs posted at the tap head. Perhaps further awareness building is in order. In the absence of any available self-regulating taps, we had to replace them with the most durable unregulated taps available locally, and make efforts to have broken ones changed (usually every 3–4 months) without delay.

**Manual versus 'automatic' delivery of water**
Manual switches – which turn pumps on and off to fill tanks – are not appropriate for solar water systems, unless there is someone responsible at the well head at specified times; this is not practical and causes conflict when the water is not supplied predictably. With an automatic design, the reservoir fills during the day and a simple float valve switch turns off the pump when the tank is full.

### *7.2.5 Security*

***Security elements introduced into design***

All water systems are vulnerable to vandalism and accidental damage. Such damage cannot be completely eliminated without some social pressure systems being put in place (see 'Security and management issues' below), but over time, we have learned to include some structural protection elements in our systems. These include: robust steel protectors embedded in concrete supports around pump heads; locked boxes around charge controllers; sturdy gates, locks and razor wire in walls surrounding systems; individually welding PV panels to the array support; and so on. Where a motion-sensitive solar security lighting system is in place, its batteries must be protected against any access, not only to protect against sabotage or theft but also against injury. Security guards are expensive and notoriously irresponsible.

**Security for reticulation lines**
In Kaiama, the reticulation line was vandalised over 13 times – as we described in the Kaiama case study (Section 4). The problem was solved by disconnecting the reticulation and constructing a fetching point with taps near the water facility itself. For communities where community spirit seems to be lost, installing taps close to the water system is the surest way to ensure system sustainability.

### *7.2.6 Contractor skills, capacity and reliability*

A company or NGO may not have all the technical capacity in-house to implement a water system, but may have an understanding of the technologies required, good community networking skills, and in some cases, experience with participatory development and socio-economics. They may therefore sub-contract out some or all of the project. The challenge then is identifying reliable civil engineering and solar system contractors who are experienced in working in our location. Contractors may turn out not to have as much knowledge or experience

as they had claimed, or may expect in turn to subcontract special skills but be unable to locate them, or be let down by subcontractors.

The work of the various skilled technicians must be coordinated when installing solar-powered water systems. Late delivery of drilling chemicals delays the use of the rig – which is hired at a daily rate – as well as the civil engineer responsible for managing the borehole drilling. A no-show welding machine owner compromises the work both of the welder and the civil engineer working on the tower and installing tanks. Contractors take payment for mobilisation and use the money for other projects, compromising their ability to pay their artisans and local labour. This commonly causes disaffection which means contractors can no longer work in that community. It is imperative that project owners are on site to monitor project implementation and to step in where problems arise.

### *7.2.7 Using local labour*

Most communities in rural Niger Delta have large numbers of under-employed youth who shun farming and fishing and have few other skills that can generate a living wage. When oil companies carry out construction activities for their work or development projects for communities, the youth show up in large organised groups, demanding employment. Contractors to these companies are required to employ local youth for specified services, mainly as unskilled labour or as a security, and in the past, this has been helpful to both parties. However, over time these groups have come to see payment for such work as entitlement to benefits from those exploiting their environment for commercial gain.

The young workers tend to spend a lot of time 'negotiating' their payment for unskilled labour and often the work agreed to is done poorly or incompletely with far more individuals being involved than should be required. This requires the contracting company to have patience in negotiating, take care in documenting the workforce, agree to higher payments than would be expected in the townships, and engage in strict monitoring and provision of all materials in order to get the work done as quickly as possible.

It is valuable to identify a few reliable people early on in a project, for continuity and to have an interface between contractor and community members during construction and afterwards. These people should include both mature adults and youth. Selecting the right people requires time to observe them in action, particularly in labour negotiation situations, and in their interaction with women, elders and contractors' artisans. The wrong people can sabotage, tell false stories, take sides and extort money, undermining good will and the community's confidence and support. This results in delays and increased costs.

### *7.2.8 The importance of technically successful solar projects*

In the past, solar power was not the preferred option for power in the Niger Delta, partly due to the number of failed solar-powered street lighting, home energy and water projects. We have now observed a groundswell of people who are showing interest in renewable energy technologies. While we welcome this, we are concerned about the lack of understanding of technical requirements to ensure that needs are met, and about the lack of technical expertise to design sustainable systems. We continue to see non-functional, badly designed and unsustainable solar systems in the Niger Delta – and these can lead to public rejection of the technology as a whole.

However, once a solar project is shown to be successful, the story gets around:

- A village near our Bomoundi project was the beneficiary of a solar-powered treatment system at the same time as ours; theirs didn't perform well. They came to Bomoundi and were impressed with the system there, asking, 'Why is your system working and ours is not? I thought all solar power was the same.'

- The continued successful performance of the Kaiama solar system is being talked about, and attracting visitors and contractors who want to know why this system worked when so many similar projects have not. People from other communities are putting pressure on agencies and companies to do for them what has been done in Kaiama.
- Both NDDC and SPDC (and hopefully others of whom we are not aware) claim to be introducing the general design principles used in NDWC and SUNGAS projects to their new solar-powered water systems.
- Because the Kaiama system continued to operate during the unprecedented 2012 floods, the state committee which is planning ahead for the 'next' flood have put water systems using the Kaiama concept on the agenda.

As the cost of oil and gas goes up, and solar technologies improve, the relative cost of solar systems is coming down – and there is reason to believe that this trend will continue. Even when such systems appear expensive, they are cheaper in the long run. They are the only realistic option for the remote riverine communities in the Niger Delta, where fuel-powered generators for pumping water have failed to provide healthy drinking water or alleviate the drudgery of carrying it long distances.

### *7.2.9 Recommendations for technical sustainability*

- There is a need to educate the public, contractors and artisans about solar energy in general, and particularly in projects being undertaken in their area – even simply by publicising successful demonstration projects for them to visit.
- There is a need for contractors and their technicians to see and study successful projects. NDWC offered to 'train' contractors including those who had had failed projects – but got no takers from government, NDDC or SPDC. Why?
- There is a need for service providers (contractors) to be accountable for the performance of the projects they have undertaken.
- A database should be established for solar-powered projects in Nigeria. It should include contractor information[23] (who has done what and what was the outcome); location and specifications of projects implemented; and sources for procuring system components, with evaluations by users. The database should be online and could be based in a government agency or NGO. It could be funded by donor agencies with ongoing maintenance supported by government.
- System design should be robust and as simple as possible. It should have no moving parts (except for the pump) and no batteries. The pumps to fill the tanks should turn on and off automatically without the need for manual operation. There must be readily available information as to how faults should be reported and to whom; and once reported, a system should be in place to ensure that faults are corrected immediately. The cost of such a maintenance service should be included in the ongoing costs of running the system, and covered through user payment (or government subsidy support).

23 NDDC published, in a national newspaper, a list of hundreds of contractors it had registered for doing solar projects; NDWC was not listed despite its work in this field, and we didn't recognise any of those that were.

## 7.3 Socio-economic and management issues

It has been demonstrated that solar energy systems can be designed to provide services for the Niger Delta. Solar-powered water systems are a realistic means of providing potable water, even in the smallest villages in the most remote areas. There is no need for contractors to continue to construct unworkable solar energy systems and then desert them.

However, once solar-powered water systems are in place, even those that are technically satisfactory still often fail after short periods of operation. The greatest challenge to sustaining solar-powered water systems is getting a workable and realistic 'sustainability plan' in place during project development. This is essential for the on-going operation and maintenance of the system after sponsors and facilitating contractors or NGOs have left the site. NDWC's experiences over the years – and particularly during the focused efforts of the SUNGAS project – have led us to the following conclusions, which may contribute to better project sustainability in the future.

### *7.3.1 Understanding a project's social context*

Power and energy projects are most often 'given' to communities based on decisions made at the top of funding chains – of governments, development agencies or commercial companies. This 'top-down' model has led to failed projects over and over again, even when the systems were technically successful. Why is this?

Contractors have been appointed for their ability to carry out the technical implementation of a project, rather than to interact with the beneficiary community. They were not funded (nor do they have the capacity) to facilitate community understanding of the project, support for its implementation and use and maintenance on commissioning. Not surprisingly under the socio-political conditions in the Niger Delta, contractors had challenges that sometimes led to incomplete projects being 'dropped', or technically successful projects failing after commissioning due to a lack of community ability to sustain projects.

The later shift to a more participatory approach, driven by development agencies and NGOs, was described as 'bottom-up'; but it still generally entered the project implementation process after those at the top of the funding chain had identified a project, selected contractors and introduced them to the community.

Sponsors and contractors have added various levels of 'facilitation' and 'interfacing' between themselves and the communities. Oil companies now have huge bureaucratic departments with hundreds of employees in their 'corporate responsibility' or 'community development divisions'. Governments require such projects to be 'monitored' by their own agents or committees, and NGOs are recruited to advise or provide specific services, both to prevent project implementation being obstructed and to enhance post-commissioning success. Unfortunately, all of these layers of management and monitoring of contractors have not increased their accountability.

### *7.3.2 Working with communities*

**Community leaders**

Communities have a hierarchy that must be respected by the NGO or contractor who interacts with the community. If an NGO approaches a community at the grassroots level – for instance through women's groups or churches – or tries to establish a project management committee without first gaining the support of the local chiefs and elders, they will fail. In some Niger Delta communities, the chiefs and elders are driven by personal agendas or the conviction that the community is 'entitled' to development freely, without any input on their part. The best indicator that a project will succeed is a chief who is prepared to support development for the common good

and ensure that the broadest spectrum of the community benefits from the project. It is therefore absolutely imperative that the leaders are in support of a development project; and gaining their support requires time, patience and continued interaction throughout the project.

**Community participation**
Following the introduction of a project to the chiefs and elders, the NGO will 'enter' the community and learn as much as possible about its natural and human resources, its social structure, conflicts within and between communities in the area, and its past experiences with development projects. This is done through a participatory rural appraisal (PRA) or a sustainable livelihood assessment (SLA) and requires in-depth engagement with the community, with local people at all levels and in all socio-economic sectors.

- These assessments are essential to evaluate a community as a possible site for a project. For instance, if a community has no existing water projects, it is important to understand why. It may be the absence of nearby oil installations or important people with connections – or because of underlying social conflicts, land disputes, land rental, and other factors that may impede a future project.
- The PRA or SLA process can identify what people see as their most important needs, and whether or not they would be willing to contribute to the costs of meeting them.
- Collecting valid data is difficult. People may be reluctant to reveal their resources, incomes and family structure; they may say they are willing to pay for services when in fact they don't believe they should, or can't afford to; or they may change their minds when faced with the reality of a situation – such as having to pay a monthly tariff during the rainy season.
- There is a need to understand local community or political dynamics in order to avoid exacerbating conflict or marginalising sections of the community from benefitting from projects; for instance the case of Aduku (see Section 5), where many residents were tenants rather than landowners.[24] It is necessary to do as much as possible with all means available to understand the power structure in the community – it is important to avoid making assumptions based on other communities or appearing to 'take sides' in community conflicts.

A participatory assessment will indicate whether or not the project is acceptable to the community, and what may need to be done to ensure the success of the project if it is to be implemented.

### *7.3.3 Planning for sustainability*

***Privately owned water systems***

We found a few private water projects that have been very successful in serving the needs of small communities; these demonstrate that technical issues can be met, and adequate services provided, but they require continued inputs by the owner and are only as sustainable as his or her pocket allows. There are very few individuals who can afford, or are willing, to operate such systems in rural areas.

24 Throughout the Niger Delta, there are communities that legally own large tracts of land that they do not use for purposes other than hunting and gathering. People from surrounding areas or even from great distances migrate to such villages 'to work the land'. They also fish, farm, harvest timber, etc. They pay a tenement rate to the owners and are restricted from anything that might be construed as implying ownership of (or title to) the land. Thus they may not be allowed to construct permanent residences or schools. In this situation, the chief of the landowner community (which is generally located some distance from the settlement) does not live in the settlement but has his 'agents' who stay there to ensure compliance. The introduction of a water system by a third party that deals only with the settlers (beneficiaries) may be objected to by the landowners; if a fee-paying water system is introduced through the landlords' chief, the settlers are likely to see it as just another means of being taxed unfairly. Such underlying social structures can scuttle the development project if it is not recognised and/or addressed sensitively.

***Sponsored water systems designed for community ownership***

Because of the high cost of energy and water systems, the vast majority are 'sponsored' from outside the community and handed over to the community for operation. Project sustainability must be a key consideration at the very beginning of this type of project. It will always be best to have an individual assigned to do regular monitoring and troubleshooting and to see that repairs are done where needed. All functional projects have daily sustainability costs. If these costs cannot be met, the project lifespan is bound to be short. Therefore economic sustainability should be considered as important as the project implementation itself.

If sponsors require that a project be 'owned by' or 'sustained' by community members, the responsibility might be given to:

- a community management committee established for the purpose
- a chief taking personal responsibility for ensuring funds are identified for sustaining the project
- a person appointed to operate the project as a franchise.

Though our work on the SUNGAS project, NDWC has had the opportunity to learn the limitations of each of these options. We have concluded that additional inputs are required if community efforts are to be effective in enhancing project sustainability.

**Sustainability responsibility taken by management committees.** A management committee can be constituted at the project implementation stage to plan for economic sustainability, as was the case in Aduku (see Section 5). However, committees require members to dedicate a fair amount of time, and most people move from one place to another, have more than one means of livelihood, have little money for transport to meetings, or time for community activities. If the management committee must collect funds from the community to sustain a system (such as for repairs, security or for taking collected payments to the bank), rules may need to be made about using the system. Once a committee is selected from a general forum, members are often treated with suspicion. They might become ineffective in their duties through undue pressure from those with vested interests or threats from people when they try to enforce community decisions. Contractors and NGOs can advise, educate and enlighten, but cannot force communities to collect or spend money they don't have, in order to sustain a project. Moreover, it is difficult to predict at the start of a project, or even following training, whether or not the community will commit to a management committee model in the longer term. Ultimately our conclusion from the Aduku experience was that a management committee alone cannot ensure sustainability, without the support of the chief in requiring local residents to make payments.

**Sustainability responsibility taken by chiefs and elders.** Chiefs and elders have some authority to make regulations in their communities. If funds are required to sustain a water system, they may have access to funds attached to their office, have the right to impose taxes, or use their office and influence to get funds from project sponsors, the State Government Water Board, the LGA, or the CDC. A problem with accessing local government or CDC funds, however, is that there is lack of continuity of office holders and sustaining a water system requires continuous attention. NGOs can help to exert influence through their networks, reinforcing a chief's efforts.

In Kaiama, the Chief initially took some responsibility for funding security and maintenance of the water pump (see Section 3.3). To date, he has continued to do so, even re-building a collapsed section of the surrounding wall. NDWC has also continued to voluntarily make those repairs requiring urgency to ensure continued service and prevent greater damage. The Chief is a retired civil servant and

thus has a personal pension income as well as his chieftaincy allowances.

In Aduku the Chief made a declaration that local residents must pay for the water system; when this failed to guarantee payment, he promised to include a fee for water in the annual tenement rate paid to the National Executive Committee. This has not been implemented to date, over a year since the 2012 floods.

**Sustainability responsibility taken by franchisee.** Finding it difficult to facilitate community management committees and local leaders to take responsibility for sustaining water systems, NDWC decided to try a form of franchise management – this project in Odi is described in Section 7. In this case, water distribution is the responsibility of the franchisee, who sells water from a system provided by a sponsor. The franchisee pays a percentage of the income into a fund for maintaining the system and keeps the balance collected for personal income. As we found in Odi, the problem with this approach was that although people are willing to pay for good water, there was little demand in the wet season when free water is available to those with rainwater catchment containers. Income from water during the dry season was not adequate to cover costs during the rains, when little was sold. There may be ways to grow a market though price-setting, delivery options and so on, but this is not ever going to be a profitable business approach. Our franchisee in Odi had other existing income streams, which was an important aspect of sustainability from her perspective, and something that the NDWC team deliberately focused on as a criterion to qualify for the franchisee role.

In conclusion, whether a project is owned by a private individual, a community or a franchise, there are reasons why it may not be sustained without a subsidy. Water systems that provide potable water are expensive to establish and to sustain, whether solar or generator-powered, and available funds in rural villages are limited.

### *7.3.4 Energy and water systems are essential public services*

Governments around the world ensure that their populace have access to essential public services, such as power and water. They may operate the services themselves, give responsibility to townships, or they may allow them to be provided by commercial companies that are regulated by laws with respect to environmental and technical standards, and equitable pricing.

In developing countries, the poor cannot afford to pay for the construction of infrastructure for installations and delivery services. Even where local taxes are collected for such services, such taxes will not cover the costs.

### *7.3.5 Community-based power and water management: is it a realistic expectation?*

There is really no such thing as 'negative data' in research or development intervention work. Sometimes you learn more from unpredicted results or failures in a process than from a success. With respect to energy and water management committees, NDWC has concluded from its surveys and from the projects it has implemented, that it is unrealistic to expect rural communities to manage projects such as power and water systems. Even when small in size, they are too expensive, and too complex, and to maintain them requires technical expertise and continuous injection of funds that are not available. This is the conclusion being reached in many parts of the world, including the developed world. Selected extracts from a few articles written at the time we were carrying out our SUNGAS work are perceptive.

**Extracts from relevant articles**
Technical expertise can be a local trained for the purpose; or it can be a designated local government official experienced or trained in pump and water system maintenance.

Rosenberg wrote in the New York Times in December 2011: 'For a few years, the conventional wisdom among water groups was that with increased village involvement, water projects would have long and healthy lives. Unfortunately, they still don't. Water Aid wrote in one important analysis of the problem: "The evolution of community management as a pragmatic response to weaknesses in public service provision, and its subsequent promotion as the ideal model of service delivery was a triumph of hope over realism"…'

'The involvement of villagers is absolutely necessary – it just isn't all that is necessary.'

'Even a well-organized, highly motivated village can't repair a water pump if there are no parts or tools available, or there is no one trained to carry out repairs.'

'Dire poverty also creates other obstacles. Water and sanitation committees are supposed to collect user fees, but this has proven very difficult. Many people can't afford anything, and some don't like to pay because they suspect – often with good reason – that their money will never see its intended purpose. Even villages that can collect a few dollars still don't come close to covering major repairs. It comes down to this: someone has to pay for repairs, and it's not going to be a village.'

(One Church in Uganda has it right: since 1986 when a village couldn't pay for a repair, the diocese has covered it – i.e. a local Anglican church has stood in for government.)

In Aduku, the Chief stands in. In Nembe, a wealthy man organises and pays for management and maintenance of public services of a water system.

In the New York Times article, Rosenberg continues: 'It's un-American to rely on government for water? Since when? Hubert B may have drilled his own well, but most Americans don't. Local governments build our water systems. And they are financed not only through user fees, but taxes and municipal bonds … It should be government's job everywhere, but it doesn't happen in many poor countries … District government officials have very little training (including few skills in how to get projects done) and their offices have very little money to spend.'

'Water charities today that are serious about their mission now realize that they have to work with district-level government – not only to get permits, but also to help officials do their job. Unlike with the WASH [water and sanitation committees], no one has any illusions this time' (Rosenberg, 2011).

**From a comparative study of Nepal, Peru and Kenya**

In her study of energy delivery models in Nepal, Peru and Kenya, Yadoo (2012) observes that local community members may not have the technical or general knowledge to assess and contribute to the design of the technology and the delivery model overall. Awareness raising and capacity building are essential:

- 'Training may be required to raise knowledge about renewable energy off-grid options among communities [and others]…Human capacity needs to be developed (for example through the training of technicians) if more projects are to be implemented at a faster pace and for the systems to be sustainable' (p.35).
- 'During a project's planning and implementation stages, overriding focus should be placed on generating a sense of local responsibility for the electricity system and its upkeep across all key stakeholders, growing local desire for the electricity services provided …' (p.41).
- '[Service providers] [b]e aware that there is no one-size-fits-all solution. Take care to tailor the rural electrification system to cater for the specific needs, desires and cultural specificities of different communities. This will be particularly relevant with regard to the choice of management model' (p.6).

- 'A system's managers and operators should be paid an appropriate wage for their services in order to maintain their drive and motivation' (p.5).

**From a study of the PERMER rural electrification programme in Argentina**

In her study of Argentina's PERMER programme (*Proyecto de Energías Renovables en Mercados Rurales*) to expand electricity access through public-private partnerships and renewable energy, Best (2011:18) observes that a key feature of the model is that it is 'a top-down, federal government-led programme, delivered in partnership with provincial authorities, with the latter responsible for execution and regulation'.

### *7.3.6 Recommendations for socio-economic and management issues*

What then can be expected of the beneficiary community? Even if communities cannot be expected to fund the technical and security sustainability costs of quality water systems, there are essential roles they can and must play to support those who provide the funds.

**Chiefs and elders**

Chiefs and elders in communities are responsible for protecting the interests of their constituencies and to seeing that their constituencies follow local norms for good citizenship. This means they will play a direct role in defining the community ownership of projects. Such projects may be handed over to the chiefs and elders at completion. They need to use all means and authority available to them to ensure such projects are sustained by ensuring that sufficient funds are allocated to the projects and that they are well-managed. They can make use of funds attached to their offices or use their authority to seek outside funds and capacity for maintaining them. In the best cases, where the responsibility for operation and maintenance of a project has been formally accepted by a state or local government department, the Chiefs and elders will still find it necessary to act as 'midwife' between the responsible department and the delivery of the service.

**A water committee**

A water management committee could be effective and feasible if members are only expected to have occasional meetings and limited responsibilities. These could include awareness-building of best practices in using their water systems within the community; being the reporting point for system malfunction; knowing where to get technical assistance; and sanctioning community members who misuse or vandalise a water system, through local agencies responsible for social regulation. They could also work with their chiefs, elders and others (such as wealthy individuals or NGOs) to influence the release of government or other sources of funds; or for getting them to take direct responsibility for security and sourcing technical capacity for system maintenance.

**General populace**

While accepting that, with few exceptions, the cost of operating, securing and otherwise maintaining power and energy systems is outside the means of the general population, it still has a role to play in:

- preventing and reporting damage, such as
  a. pipes being broken from agricultural, road and building construction activities, and taps being broken through rough use
  b. vandals breaking pipes, damaging control boxes, stealing pumps, and so on
  c. taps being allowed to run when water is not being collected.
- seeing that vandals are sanctioned by chiefs, elders or other responsible leaders.

Communities must be still be part of the process; they must be taught how the systems work, how to maintain them and where to get help when it is required.

## 7.4 The relationship between project sponsors and NGOs

NDWC has carried out development work in the Niger Delta since 1993. During the first decade of our work, we looked at how to solve the problems for which our NGO was established: natural resource management and improving the quality of life for the people in our target area. Based on our academic and social experiences, we wrote proposals for grants to address these issues to international NGOs and funding agencies, to oil companies operating in the area, and to government agencies.

In the early days of our experience using grants, the conditions required by the funding agents were generally flexible in terms of how projects were implemented, and they were focused on the activities described in the proposals. Grants were monitored directly by the funding agents, based on narrative and financial reports, which were adequately spaced to allow focus on work rather than bureaucracy. Financial reporting was based on generally broad budget lines, and financial claims were accepted based on evidence that expenditures were reflected by the activities described in the narrative reports.

Over the years, there have been calculable changes in the way many sponsors of development projects – international NGOs, foundations and agencies, multinational companies and governments – relate to NGOs. There is a trend toward using NGOs as 'service providers' (i.e. delivering on the sponsor's own goals, in communities favoured by the sponsor), rather than supporting the NGO to implement projects through grants designed with their involvement from inception. Some sponsors are known to excessively micro-manage projects. This has made it increasingly difficult for NGOs to get the satisfaction of seeing their constituencies benefit from the projects they implement. It has made it almost impossible for NGOs to fund institutional strengthening activities and build human capacity: having to implement discrete and narrowly defined projects contracted through tender has made it increasingly difficult for local NGOs to be established and grow and for strong local NGOs to be sustained. It has also blurred the definition of NGOs and their traditional objectives.

Funding agencies and companies and governments appear to prefer NGOs that can be micromanaged and don't challenge their objectives. Many of the enthusiastic and idealistic NGOs that started up in the 1990s are now 'off the radar', and can only afford to operate from their villages.

While a full discussion of these trends would best be done in a forum dedicated to the purpose, we believe it is important to briefly highlight these issues and their implications, as they have affected our work with SUNGAS and other sponsors in promoting solar-powered water systems in the Niger Delta.

### *7.4.1 Grants versus contracts*

Here we draw a distinction between 'grants', which are comparatively flexible and given in response to a project proposal approved by a sponsor; and 'contracts', which are fixed, having been conceived and specified for implementation by the project sponsor. However, with the increase in bureaucracy of grant-giving processes, the line between these two types of document is becoming blurred.

Where previously grant applications may have taken up about 10 pages, with a grant approval document of 3 pages, the application documentation – be it for a grant or a tender – now extends to around 50 pages. And now both grant agreements and service contracts tend to extend to 20 or 30 pages of legalistic regulations. This gives local partners the impression that sponsors want to be protected from anticipated sub-standard and corrupt implementation – even in the case of a grant.

### 7.4.2 Project design

Projects have become larger and more complex, as sponsors find that the 'transaction costs' of larger projects are more manageable. Often multiple diverse organisations are expected to work together; sometimes without previously having worked together or even knowing one another. This requires the sponsors and the organisations managing large projects to increase the layers of bureaucracy within their organisations and between their own organisation and the implementing 'partners'.

In the case of large-scale grants, a lead organisation is often required to 'manage' the local partners, providing an additional layer of reporting and bureaucracy between the sponsors and the implementers on the ground – something that may be very onerous on international organisations that have traditionally built much less bureaucratic relations with their local partners. Multinationals will have their own in-house complex of community development departments, sub-departments, project owners and monitors; they often appoint NGOs and 'independent consultants' to interface between themselves and implementing NGOs or contractors.

All of this layering has two important results: first, there is now an almost total lack of direct communication or personal interaction between sponsor and local implementers, and second, there is an inevitable dilution of funds spent in the name of beneficiaries but actually of more benefit to others in the chain.

Increasingly, the notion of 'partnership' is being undermined, with sponsors becoming the *de facto* 'owners' of a project and the local implementing organisations increasingly becoming the 'service providers'. The term 'partner' cannot be used about two organisations with major disparities in power, influence and wealth. Oil companies actually use the term 'project owner' to refer to an individual who interfaces between the company and an NGO. That person may simply monitor and report to the company or may in fact micromanage, imposing their own vision and procedures to the detriment of both the project and the service providers. In the case of international project grants, an overly bureaucratic arrangement between an international organisation and local partner may pose challenges when trying to build trust and a respectful working partnership.

Drafting log frame analyses, risk assessments and work plans is useful for ensuring that project implementers provide evidence that they have 'thought through' what they plan to do, what risks there are to their approach and what outcomes they expect and will measure using indirect indicators. This exercise at the beginning of a project is a useful exercise; from experience, however, it loses value as the project progresses and periodic revisions may not add more value.

### 7.4.3 Data collection

The collation of information about the resources and needs of the beneficiaries of a project is essential, as every community is different. In Niger Delta communities, major changes have occurred over the past 30 years with respect to natural resources availability and livelihood sustainability, as well as the impact of the oil industry on the environment and social structures; as a result, people's perceived needs and their expectations of how these will be met have also changed dramatically.

Gathered data establishes a description of the situation and guides how a project will be implemented. It also provides a baseline against which impacts of the project can be measured over time. Project sponsors insist on continuous data collection and analysis as part of their project and assessment reports. NGOs have two concerns about such data collection, which often becomes labour- and cost-intensive.

- First, the transparency of information that individuals release is questionable: people often tell you what they think you want to know

– or what they want you to think is true – rather than what they perceive to be true.

- And second, the 'trends' or 'impacts' extracted from the limited numbers of people interviewed on the short operational periods of most projects can rarely be considered valid.

Below we summarise some of the reasons why it is difficult to measure the effectiveness or success of a project using standard project monitoring tools:

- A project that is to be funded for three years may require two years to construct; is the final year adequate to measure the project's utility and its impacts against the project log frames and risk assessments?
- If a water project is to have a positive impact on the health of local residents, can that be measured when only 10 per cent of the population uses the water intermittently? Reports of water-borne diseases cannot show up in health records, because 90 per cent of medical treatment is done by patent medicine store dispensers or with traditional medicine.
- How important is it to know that 80 per cent of people use kerosene some of the time, or for an average of two hours a day, if we know that everyone we ask says they 'use it when needed'?
- If you ask people if they pay for cell phone use and they say 'yes', and you ask them if they would be willing to pay for potable water, they will also say 'yes'. When the time comes to pay for water, they will not pay, or only a few will pay.
- If you ask people about land use conflicts, they may say 'no' when in fact there are serious problems in this regard. They may think that evidence of conflict could compromise their chances of getting a project.
- How valid is any 'absolute' data in a community of less than 100 families, when only 20 people are willing to be interviewed?
- Community transformation is incremental, step by step – and takes a very long time, no matter what change is being introduced. Moreover, there may also be several factors contributing to the change – for example, evidence of a reduction in childhood diarrhoea cannot be attributed solely to an improved water source.

### *7.4.4 Visibility requirements*

NDWC has encountered people's general belief in the Niger Delta that they have been exploited, their income-generating resources and land destroyed, and their social fabric disrupted; they are therefore 'entitled' to compensation, mitigation, and development. Any project identified as being associated with Shell, World Bank, NDDC, or indeed the EC, is seen as 'owned' by the institution bringing it – and so the community should not be expected to have any role in generating funds for the purpose of construction, management, operation or sustaining it.

While it is impossible to prevent a community from knowing who the sponsors or NGO facilitators of a project are, it is helpful if those sponsors or facilitators keep their profile low in the initial stages of a project. It is also helpful if the NGO facilitators are identified by the community as being 'part of them' or as having contributed to their wellbeing one way or another in the past. A project can more safely and responsibly be publicised by a sponsor once it has 'proven' itself. At this stage a visible logo will reinforce a positive perception of a sponsor rather than raise a red flag.

### *7.4.5 Replicability*

Project sponsors often define one measure of a successful project as its replicability. However, development projects are not 'replicable'; they are site-specific with respect to many key specifications. Service providers require open minds about what is to be done, and how, in a particular location.

NGOs know that what works in Bornu may not work in Apoi Creek; that what works in Yenagoa may not work in Aduku. They understand that a project's capacity to be replicated has limits, and they want to expose those limits for consideration in designing projects. It is far more important to NDWC to have three solar-powered water projects with different specifications that all deliver a good service, than 20 identical projects of which only two or three are sustainable.

### *7.4.6 Responsive interface with communities*

If communities don't behave as we think they should, do we walk away? Do we persuade them to change? Or is it okay to make compromises, to change the project design, to do anything possible to ensure the deliverables are delivered and sustained *somehow*? External project fund managers frequently don't have much understanding of what it is like to work in a foreign location or part of a country that they are unfamiliar with. They may attend meetings or make site visits as visitors or 'strangers', but they do not really know what it is like to be a villager in that location, to be an NGO sending staff there, or to work with people who are always saying what you want to hear and what they want you to hear – though what they are saying may not be the whole truth.

### *7.4.7 Matters of trust and financial management*

The increased bureaucracy surrounding grant-giving has served not to increase confidence between implementing partners, but to undermine trust – a key element of working project relationships.

Excessive financial reporting requirements lead local partners to feel that the sponsor assumes they are going to steal funds and claim for things not done, and therefore there is a need for them to be closely supervised and not allowed to use creativity or initiative, or adjust activities to improve the success of the project. There may be some cases where financial mismanagement takes place, but a larger truth is that there are very real constraints to working in our locations that are not generally met in Europe or America. Costs of utilities, maintenance, transport (especially transport by water) are high. Costs of communication, particularly internet connectivity, are also high.

Sponsors often raise questions when NGOs pay their staff or field workers a reasonably comfortable wage. I struggle to ensure that we pay skilled and experienced temporary field staff more than they are paid by the expatriate on a short field site visit who feels generous when he pays his field guides NGN3000 (US$19) a day. Moreover, the 'cost of a position' is different from the 'salary paid'. This is because (a) Nigerians do not have a formal social security system or a health insurance scheme or pension plan. Employers take 'informal' responsibility for matters that arise (such as illness, deaths, births, transport accidents, inability to meet school fees) as is possible; (b) there are substantial costs of recruitment of staff, from overlapping appointments of new staff with those leaving an organisation to paying benefits to staff at the end of a project or appointment. These costs must be built into the cost of all staff in planning budget lines.

It is difficult to work with agencies that expect regular detailed reports, work plans, financial plans, narrative and financial reports, and meetings. Too much time is required for these competing and overlapping activities – diverting time that could be better used in the field.

Budget lines are set in the project budget (which is included in the grant application or tender proposal). But how funds must actually be spent evolves over the life of a project. A budget line for a specific activity may sound good at the outset, but turn out to be counterproductive or inappropriate at a later stage. If costs of utilities are not fully predicted in the original budget, a later claim for power may appear exorbitant to sponsors, who may

not have a realistic understanding of the cost of power in the prevailing conditions at project locations.

Project sponsors insist on evidence of spending transactions. It is reasonable to expect evidence of officially receipted utilities payments, but how is one expected to provide evidence for cell phone charge cards, motor-bike taxis (such as for carrying diesel fuel for the generator), river speed-boat taxis, and lunch at local food vendors? Lump sum, per-diem payments for field workers – previously a practical and reasonable option for handling these small sums – are increasingly being rejected by sponsors.

### *7.4.8 NGO in-house capacity versus outsourcing*

Project sponsors seem to prefer that an NGO outsources work to other NGOs or companies, for instance for holding a workshop, doing site visits or holding meetings with a community water management committee. Donors often refuse to accept an in-house non-receiptable expenditure claim and expect a 'proper' invoice issued and paid by the NGO, which can only be obtained through outsourcing. Yet the cost of outsourcing these activities, for which the NGO has the expertise, is greater than doing them 'in-house'. We think it a sensible practice to do everything possible in-house, and the only realistic way to get bang for funding bucks. But when a workshop is to be handled at the NGO's premises and run by its staff, as a way to use fixed grant money carefully and to save funds for other grant uses, it is difficult to provide documentation that is acceptable to the donor.

### *7.4.9 Requiring tenders for procurement*

Procurement of the right products and skilled services is critical to success in any project. If one is to purchase high quality solar components for a project in Nigeria, in most cases it is necessary to import them. If one has procured quality items through a supplier familiar with the import regulations and logistical requirements for sending goods to Nigeria, the best way to procure the items is to continue to use that supplier. Similarly, if one is to contract a skilled engineering service out to a company in Nigeria for implementation, it is better to use a contractor one knows and has worked with before.

However, under the procurement requirements of many project sponsors, one is required to get three tenders for these procurement actions. Most suppliers or civil engineering firms are not interested in spending the time and money required to produce a serious tender document when they know there is little likelihood of their tender being selected. Would it not be better for the project sponsor to consider other options for assessing the quality of goods and services that the service provider intends to use?

### *7.4.10 Funding challenges*

Project funding approval is often delayed for long periods, even for projects that may only take a few months. NGOs cannot be sustained by the occasional short project. Most NGOs take such projects, either because they need any funds they can get, or because they believe it will lead to other opportunities to work with the sponsor. Experience shows this doesn't often work. When the processing time for project approval is delayed, what are such NGOs to do while waiting?

Large development agencies have required co-funding as part of their contracts for some time, and oil industry development programmes are now also requiring it. Co-funding is project funding independently raised by the implementing parties to match the funds offered by the sponsor (perhaps around 20 per cent of total project costs). This can mean that if no co-funding is obtained by the implementing partner, their budget is reduced. It is very difficult for local NGOs to find co-funding when they have no institutional funds to cover their time spent on soliciting grants, and no project budget line is provided for this activity. Further fundraising moreover becomes a distraction from their

project activities, which are already being done under difficult conditions.

## 7.5 Final reflections

In NDWC's experience of more than 20 years, the SUNGAS project has been one of the most difficult of our NGO projects. IIED's staff have had a thankless job; they must have found themselves under a constantly changing series of pressures and deadlines. They, too, must have felt they were under scrutiny at times when they needed advice and encouragement. Admittedly this was not always understood or appreciated by NDWC or other service providers, for whom IIED was the 'middleman'.

Yet despite its challenges, the SUNGAS project has been a huge opportunity for learning – of both positive and negative lessons. We hope that this book will catalyse lesson learning on the part of the EU and all the SUNGAS partners, as well as subsequent sponsors and implementing partners engaged in project development in the Niger Delta.

# References


Bellonwu, Vivian and Henshaw, Ken (2012), *The 2012 Floods: Human rights and accountability in the management of emergency relief in Bayelsa State and Rivers State*, Social Action Briefing No. 5, 5 December 2012, Social Action, Port Harcourt, Nigeria.

Best, S. (2011), *Renewable Energy for Rural Electrification in Argentina: a case study of PERMER*, IIED, London.

Collins, Emmanuel Aku, Aku, Ngozi and Isoun, Miriam (2006), *NDWC Survey of Solar Systems in the Niger Delta,* March 2006, NDWC, Yenagoa, Nigeria.

Ezenwaka and Akinsola (2006), Niger Delta Conservation and Sustainable Development programme (ND-CSD).

IIED (2011), *Remote access: Expanding energy provision in rural Argentina through public-private partnerships and renewable energy: A case study of the PERMER*, IIED, London.

Isoun, M. (2006a), 'Renewable natural resources of the Niger Delta and challenges to their management' in A. Ezealor and O. Akinsola (eds), *The Renewable Natural Resources of The Niger Delta: Options for Sustainable Management,* Nigerian Conservation Foundation, Lagos, Nigeria, pp. 43–69.

Van Lamoen, Ilse (2006), Solar Energy Technical Training (SETT), in-house manual, Niger Delta Wetlands Centre, Yenagoa, Nigeria.

Obot, E. (2006), 'Biophysical characteristics' in A. Ezealor and O. Akinsola (eds), *The Renewable Natural Resources of The Niger Delta: Options for Sustainable Management,* Nigerian Conservation Foundation, Lagos, Nigeria.

Rosenberg, Tina (2011), 'To maintain water pumps, it takes more than a village', *New York Times*, 13 December 2011.

World Bank (1995), *Coastal Zone Management in the Niger Delta*, Vol 1 & 2, World Bank, Washington DC.

Yadoo, Annabel (2012), *Delivery Models for Decentralised Rural Electrification: Case studies in Nepal, Peru and Kenya*, IIED, London.

# Appendix A
# NDWC survey of solar-powered projects in the Niger Delta, 2006

| SPONSOR: | SHELL PETROLEUM DEVELOPMENT COMPANY (SPDC) |
|---|---|
| LOCATION: | Obelle, Emohua, Rivers State |
| STATUS: | Not functioning |
| DESCRIPTION: | Large solar-powered water system sponsored by Shell Petroleum Development Company (SPDC), costing US$1.1 million (in 1999).<br><br>The borehole is reportedly 600 metres deep, with a 225,000-litre tank, 30 photovoltaic panels clustered in six arrays of five, fitted with trackers. It has 60 dry cell batteries. The system was inefficient in pumping water and worked for only two months. An armoured cable was then connected to a distant SPDC flow station generator and a 10 horsepower AC pump replaced the expensive DC solar pumps. The cable was vandalised by youths. Security guards were not paid despite SPDC agreeing to do so. The panels were then stolen. |
| COMMENTS: | NDWC read about this SPDC site in Punch magazine, 17 December, 1999. We visited the site early in 2000 when it was about to be commissioned and water was being pumped; our staff found both the contractor (Structec) and SPDC officials overtly hostile to inquiries. At the time of our survey in 2006, there was no water from this system for the intended recipients, 22 villages in Obelle. We met members of the Council of Chiefs and a member of the water project committee,[25] which has not been effective. The village had used mainly hand pumps in the past, but the water has high iron content. There was some verbal indication that the community is willing to contribute to the cost of maintenance of the SPDC system. Community members have tried unsuccessfully to get SPDC to come back. |

25 Local community members who are responsible for managing the water system.

| AGENCY: | JAPANESE AID AGENCY (JICA) |
|---|---|
| **LOCATION:** | Umuikoro/Opehi, Ngor-Okpala LGA, Imo State |
| **STATUS:** | Incomplete |
| **DESCRIPTION:** | Federal government project sponsored by JICA, located in a small farming community which is friendly to informal visitors. Installations use 60-watt silicon photovoltaic panels and sealed deep cycle 12-volt batteries. They consist of: (1) light points, small black and white television, refrigerator in the public hall (8 panels); (2) street lights; and (3) 80 small home systems (SHS) with each with two 12-watt bulbs and an outlet for a radio. The contractor was from Lagos and all the workers were from Lagos. In 2006, construction was nearly completed.<br><br>JICA contractors have had a series of participatory awareness-building activities about solar energy. The community has a committee for troubleshooting which includes local electricians. The community has been told and accepts that it will pay a fee for sustainability – they don't know how much yet. |
| **COMMENTS:** | The village has no oil industry presence. The men asked NDWC for investment to create jobs for the unemployed and the women requested a health centre. The beneficiaries like the solar systems, but would like to be able to have power sockets to plug in other items, such as a television and fan. While the concept is good, it is slightly 'stripped-down'– the project seems minimalist in design and service. There are existing water systems: small tanks of 1000 litres, shallow wells and ancient generators, which the town buys fuel for as a cooperative. |
| **POST-SCRIPT:** | A return trip to the project in 2008 found that many of the small home systems are not working, since most people had not used them according to the instructions. The systems that had been used correctly were still working. There is an effective community security system that has prevented systems from being vandalised. |

| AGENCY: | DELTA STATE RURAL WATER SUPPLY AGENCY (RUWASAA) |
|---|---|
| **LOCATION:** | Abigborodo (1) |
| **STATUS:** | Not functioning |
| **DESCRIPTION:** | Installed in 1999 by RUWASAA. It stopped working after three years. There is a 20,000 litre tank, 24 panels still on site, and a 1960W control box. |
| **COMMENTS:** | The community urged our NDWC team to put their system back in order. |
| | |
| **LOCATION:** | Onyeburu |
| **STATUS:** | Functioning |
| **DESCRIPTION:** | Small solar-powered water system with four photovoltaic panels and a 1500-litre tank. This system was installed by RUWASAA in 2004, an upgrade from the community manual pump. Water was good initially but reported to have become contaminated by rusty pipes. There has been no awareness building and no one knows how to maintain the system, although one member of the community works in a government office in Asaba and acts as a contact. Security is provided by community vigilantes who demand money from visitors. There is not enough water to meet the community's needs. |
| **COMMENTS:** | The chiefs and elders urged us to convince the government to upgrade their water system. |
| | |
| **LOCATION:** | Jesse Town |
| **STATUS:** | Functioning |
| **DESCRIPTION:** | Small solar-powered RUWASAA water system with four 60W silicon photovoltaic panels. This was similar to the one at Onyeburu in capacity and solar components. It is located on town hall premises. |
| **COMMENTS:** | We confirmed that it is functional and in use. A meeting being held in the town hall prevented us from meeting elders and photographing the system. |

| | |
|---|---|
| **LOCATION:** | Mechanic Village and Emosorie near Oleh Main Town |
| **STATUS:** | One functioning, one not functioning |
| **DESCRIPTION:** | Two small solar-powered water systems provided by RUWASAA in villages near Oleh Town. Mechanic Village has a 1000-litre storage tank installed two years ago. People don't know how it works or who to contact if there is fault. Mechanic Village's system is functional but the system at Emosorie had been vandalised. |
| | |
| **LOCATION:** | Oviri near Olomoro |
| **STATUS:** | Not functioning |
| **DESCRIPTION:** | This was the largest RUWASAA system we saw on our survey. Installed in 2002, it only worked for a year and was still non-functional when we visited. The town had called a government official who couldn't trace the fault and removed the solar pump to prevent damage. The specification is similar to the Abigborodo (1) system above: a 20,000-litre tank, 24 panels, a 1960W control box. The tank had no sensor to automatically switch off the pump before it overflows, so it had to be turned off manually. |
| **COMMENTS:** | When the system worked, water was reported to be very good for drinking; people were coming from 10 kilometres away to collect some. It is sited in a secure school compound; the community provided guards. They have now resumed using shallow wells, and attribute increased sickness to the poor water quality. Townspeople urged NDWC to help rehabilitate their system. They are willing to contribute to the cost if it is reasonable. |
| | |
| **LOCATION:** | Ikiagbodo, near Olomoro |
| **STATUS:** | Functioning |
| **DESCRIPTION:** | Mini solar water scheme constructed by RUWASAA. The system is functional and there is no taste in the water to indicate any impurities. It was installed in 2004 in an existing manual pump borehole. It has four photovoltaic panels, a 1500-litre tank, and a manual switch to operate the pump. |
| **COMMENTS:** | The community was not informed in advance of the project or how to use and maintain it. There are other AC pump/generator water systems in the area. |

| SPONSOR: | CHEVRON |
|---|---|
| LOCATION: | Adagraza, Delta State |
| STATUS: | Incomplete |
| DESCRIPTION: | This Chevron solar water system with a treatment plant and a 600-metre borehole was under construction. |
| COMMENTS: | NDWC wrote to Chevron with a critique of the specifications used for this project, but did not receive any acknowledgement. |
| | |
| LOCATION: | Abigborodo (2) |
| STATUS: | Incomplete |
| DESCRIPTION. | A solar water system at this site was planned by Chevron to start by March 2006 and completed within three months. It was to have a three horsepower pump placed at a depth of 75 metres. NWDC had tendered for this project; Chevron arranged for NWDC to visit the site with two other contractors who were not introduced to us. NDWC followed up with a proposal based on Chevron's specifications but there has been no response. |
| **SPONSOR:** | **US DEPARTMENT OF ENERGY** |
| LOCATION: | Kuje, near Abuja airport |
| STATUS: | Not functioning |
| DESCRIPTION: | In 1999 the US Secretary of Energy, Bill Richards, launched a US Department of Energy UV water sterilisation system in combination with a fibre filtration device near Abuja. It had a solar pump, two photovoltaic panels, and a small plastic storage tank. It is located in a community market. It worked at commissioning but no longer works. |
| COMMENTS: | NDWC visited in 2004 and were told by local government officials that it has not worked since commissioning. There was not enough water in the shallow well to activate the pump. The system is too small for even a family; the filter and UV sterilisation system are impractical as they require expensive consumables and regular maintenance. |
| | |

# Appendix B
# Extract from a Letter to Chevron from NDWC in 2006

For several years, NDWC has been corresponding with, and visiting Chevron, (and earlier, Texaco) with respect to addressing the ever-present power problems in the remote riverine villages of the Niger Delta with solar energy. We have had one-on-one discussions and group discussions with Chevron and Texaco staff; we have made presentations to all levels of your organisation, and finally late in 2005, submitted an invited formal tender for a project proposed by you for Abigborodo.

While that tender was being processed, we were once again, invited by you to 'get involved' in a new project at Adagraza Community. Based on the information given about that project, we had the feeling that NDWC's experience could contribute to re-evaluating its design. We then – freely – wrote a thoughtful and constructive critique of the concepts and elements and of rural solar solutions in general (virtually, a workshop outline!). I had hoped that we would be able to meet with you and discuss my comments and concerns, and work with you to design a most-likely-to-be successful water system for Adagraza.

## NDWC site visits to solar projects, 2006

Because we were not getting acknowledgement of our correspondence, in 2006, a team from NDWC carried out an (un-funded) extensive survey of site visits to solar systems in Delta, Rivers, Imo and Bayelsa States, which is attached. We found that solar systems, whether done by oil companies or governments were often ill-designed (obvious faults – overkill without technical understanding) and most often failed after brief success (much like generators). In cases where they were installed with a facilitation component (NGO or development agency-facilitation), they were more successful. But even in these cases, sustaining good relations and supportive interaction between oil company staff/contractors and community members was not achieved after projects were completed.

We believe that the following brief summary of our selected findings ought to be of interest to your community development, PR, and engineering staff. Your comments and suggestions would be highly welcome - especially if they relate to 'good' solar projects you know about and that we have missed and should visit.

When I was finally able to confirm *through repeated inquiries*, that we had not been given the opportunity to install the system at Abigborodo, we had to re-consider whether we were being 'used' in one way or more (for 'free information' or to make the tender list look good and meet due process requirements etc.) or whether our proposals are out of sync with what is required or are that they are un-realistic, etc.

There are an increasing number of solar system product vendors, who know little about design and installation of systems and do not have technicians to assist customers to do so. Oil companies appear to be 'naïve' about solar energy and do not appear to have expertise in this area either and the favored oil-company-contractors selected often do not have experience hoping to 'farm out' that aspect of the contract). They spend 3-4 times what

is required and do not do the most important awareness-building, training and sustained involvement required (of course this would take continuous genuine commitment and much time).

So we continue to ask you and ourselves questions:

Why are unrealistic and often poorly designed projects specified in tenders? Why are inexperienced and unreliable contractors used? Why are solar systems being designed to mimic earlier grandiose generator projects when solar is ideally suited (for practical use and in terms of cost) for small, manageable systems? Why are projects 'dropped' without preliminary and post-project community interaction ensured? Why are there so many reports of failed solar projects being circulated (they are joining the ranks of failed generator projects). Or are we mis-informed?

We keep asking ourselves these questions… And are now also asking you (Chevron), SPDC, NDDC, and national and state water and energy agencies the same questions.

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The remote riverine communities of the Niger Delta inhabit a rich tropical rainforest ecosystem, surrounded by 'water, water, everywhere, but not a drop to drink'. Only the deepest boreholes provide reliably clean drinking water, but power is not readily available to pump it to the surface. While solar energy presents itself as an effective solution, numerous failed solar water projects in the Delta have lent this option the reputation of being unworkable. This paper describes how the Niger Delta Wetlands Centre (NDWC) has tried to find the most effective ways to provide potable water using solar-powered systems, and to understand the challenges – both technical and socio-economic – that must be overcome for communities to sustain them.

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