

Disseminating the SODIS method: Which approach is most effective?

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In partnership with selected Asian and African non-governmental organizations (NGOs), solar water disinfection (SODIS) projects were implemented in eight countries. The main aim was to introduce the SODIS method, as an option to treat drinking water at household level, to a large section of the population that have limited access to microbiologically clean drinking water. Following an initial pilot phase, the projects implemented a scaling up phase. Primarily two approaches were used – working with NGOs and working with government agencies – based on the choice of local partner organizations available. To demonstrate these different implementation approaches, two SODIS projects as case examples from Uzbekistan and South India are presented. Although working with government agencies involved more bureaucracy and took longer, this article concludes that working with the government resulted in greater scale and more sustainable results than working with NGOs.

Keywords: solar disinfection, capacity building, Uzbekistan, India, domestic water quality, scaling up, health impact

Water poured into a plastic bottle and exposed to full sunlight for six hours is suitable to drink

SODIS IS A SIMPLE METHOD to improve the quality of drinking water by using ultraviolet radiation from sunlight to inactivate pathogens causing diarrhoea and other water-borne diseases. Contaminated water poured into a plastic bottle and exposed to full sunlight for six hours is suitable to drink. The method was initially discovered by Professor Acra, at the American University of Beirut (Acra et al., 1980, 1984), while M. Wegelin, at the Swiss Federal Institute of Aquatic Science and Technology (Eawag), conducted further scientific investigation in the laboratory (Wegelin et al., 1994) and field testing. Further, studies conducted by other scientists have proved the effectiveness of solar disinfection in treating drinking water (Joyce et al., 1996; Sommer et al., 1997; Reed, 1997; Mc Guigan et al., 1998; Berney et al., 2006). The SODIS method is recommended for treating drinking water at household level. As microbiological contamination is not visible, the following four criteria could be tentatively used to assess water quality: (1) frequency of water-borne diseases such as diarrhoea in the family

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particularly in children; (2) physical proximity of underground water sources to polluting sources such as latrines, animal dung, drainage water and so on; (3) flooding of water sources that are not protected or covered during rainy seasons; and (4) checking water quality using inexpensive and user-friendly methods such as the presence-absence test, suitable for rapid assessment of faecal coliforms (Ramteke et al., 1994).

With technical support and supervision through the department of Water and Sanitation in Developing Countries (Sandec) of Eawag and co-financing from Solaqua Foundation, 11 projects were implemented during the period 2002–2006 of which eight projects are continuing. The main goal of the projects was to promote and disseminate SODIS as an alternative option to treat small quantities of water at a household level in developing countries where access to microbiologically clean water is limited. Through a pre-determined selection process, the potential NGOs from Asia and Africa were selected, as partner organizations of Eawag. These partner organizations implemented SODIS projects in their respective countries in cooperation with either the government or NGOs. At the end of four years, over 1 million people are using the SODIS method to clean microbiologically contaminated drinking water in peri-urban settlements and rural villages in Asia and Africa. Consequently, in communities using SODIS daily, the incidence of water-borne diseases such as diarrhoea were reduced by 20–50 per cent in children below five years of age (Annual Reports, 2002–2006 of SOLAQUA funded SODIS projects). Similarly, other health impact studies show reduction in diarrhoea and other water-borne diseases when SODIS water is regularly consumed (Conroy et al., 1996, 2001; Hobbins, 2003; Rose et al., 2006).

The main goal was to promote and disseminate SODIS for treating small quantities of water for domestic use

Implementation strategy

The SODIS project implementation strategy comprised two phases: an initial pilot phase followed by a scaling-up phase. The pilot phase primarily focused on assessing the effectiveness of the SODIS method under local conditions, the health impact in terms of diarrhoea reduction and social acceptance. The results and the lessons learned were used for preparing the advocacy and scaling-up phase. The scaling-up phase aimed at wider promotion and dissemination of SODIS, reaching a large number of people in cooperation with appropriate government agencies and local NGO networks. To mainstream SODIS into government programmes, the scaling-up phase emphasized incorporating SODIS in public health and education programmes, as one of the water treatment options at the household level. This process is essential to sustain the SODIS programme through building local ownership and commitment at the government level.

To mainstream SODIS it was incorporated into public health and education programmes

Scaling-up phase

Based on finding local partners in the country for the scaling-up activities, implementation is divided into two approaches: approach I – scaling up through government agencies and approach II – scaling up through local NGOs.

Four organizations adopted approach I: Joint Development Agency International (JDA), Uzbekistan; Community Action Programme (CAP), Pakistan; Environment and Public Health Organization (ENPHO), Nepal; and Assam University (AU), Assam, north-east India. The remaining four organizations used approach II: League for Education and Development (LEAD), South India; Kenya Water for Health Organization (KWAHO), Nairobi, Kenya; Christian Community Services (CCS), Eldoret, Kenya; and Adventist Development and Relief Agency (ADRA), Cambodia.

Scaling up through the government

In this approach, the partner organizations worked with government agencies such as health, education or municipal authorities to implement SODIS projects. The main aim was to institutionalize SODIS in the relevant ongoing programmes. The process began with effective advocacy at the policy level and gradually incorporated SODIS into regular government programmes and projects. Strategically, good reputation of the partner organizations, sound working relationships with the government agencies and positive results of the pilot phase were instrumental to institutionalization while a SODIS workshop attended by key decision-making officials provided an enabling environment. The main advantage of working with the government is that the SODIS information disseminated through the government channel gained credibility and legitimacy and hence was better accepted by the users. However, some of the challenges included delays in setting up formal cooperation and implementation of the planned activities due to complex bureaucracy.

The main advantage of working with the government is that the SODIS information gained credibility

Scaling up through the NGOs

With this approach, the partner organizations decided to scale up through local NGOs that have appropriate ongoing initiatives. The main objective was to multiply the SODIS disseminating organizations in the region and hence cover a large section of the population. The potential NGOs were selected using a set of selection criteria and the key members trained to implement SODIS in their ongoing field project activities. Key factors such as NGOs' working relationships with target user communities, organizational capacity for quality work and priority to the project determine the success of

this approach. The main advantages are the simple process involved in setting up cooperation and smooth field implementation. However, the sustainability in terms of continuity of the project is questionable, as these local NGOs depended on external funding support.

Making the case for SODIS: health impact studies

Three different diarrhoea reduction studies were carried out using different methods, sample sizes and periods of study; however the results are comparable: between 31.3 and 42.3 per cent reduction in diarrhoea incidence. This indicates consistency between the studies. These diarrhoea reduction studies were conducted as a part of the project activity to measure the health benefits of SODIS in the user families.

The average diarrhoea reduction in children below five years in Pakistan was 35.6 per cent. Two government health posts, each covering four villages were selected as a sample and diarrhoea cases were monitored over a period of four months (May to August 2005) before SODIS was introduced. The sample villages were monitored again in 2006 (same period and months) after the introduction of SODIS. The data were collected by trained female health workers who used questionnaires during house visits. The average number of children monitored was 302 in 2005 and 318 in 2006. Data was collected and analysed by the project team.

In addition, the diarrhoea cases in children under five years in 67 villages that were using SODIS against an equal number of control villages (without SODIS) were monitored for two years (2005 and 2006). The data were collected from the government village health posts, as the project was implemented through the health department. Using 2004 as the baseline (before SODIS was introduced in the villages), the result showed an average reduction in water-borne diseases by 41 per cent (ranging between 25 and 57 per cent). Data was collected and analysed by the project team.

Similarly, a diarrhoea reduction study in children less than five years old in two communes of Rovieng district, Preah Vihear province, Cambodia, showed a reduction of 31.3 per cent. The study compared 225 SODIS user families against 295 SODIS non-user families over a period of 6 months (September 2004 to March 2005). The data was collected and analysed by a PhD candidate, a team member of ADRA, Cambodia.

Another study in the slums of Kibera, Nairobi, Kenya, that compared diarrhoea reduction in children under 5 years showed an average reduction of 42.3 per cent. A randomly selected sample of 60 daily SODIS user families were compared with non-user families during the project implementation period in 2005. The data was collected

The average diarrhoea reduction in children below five years in Pakistan was 35.6 per cent

Two government health posts monitored the incidence of diarrhoea before and after SODIS was introduced

and analysed by a Swiss consultant for KWAHO's SODIS project in Kibera.

To demonstrate the two approaches to scaling up of SODIS, two cases from the field are presented below. Case I represents an experience of JDA with the Government of Uzbekistan, while Case II represents the field experiences of LEAD with the local NGOs in Tamil Nadu, South India.

Case I: Scaling up through the government in Uzbekistan

JDA International in brief

Joint Development Associates (JDA) International, Inc. is a US-based international development NGO. Its mission is to assist in the transformational development of local communities by helping initiate and implement projects in areas of clean water, poverty alleviation, infrastructure development, community health education, agriculture, and emergency aid and relief. JDA's focus is on the developing countries in Central Asia. Access to clean drinking water is one of the most pressing needs in rural Central Asia, thus making SODIS an appropriate solution for household treatment of drinking water.

Scaling-up process through the government

Initially the pilot phase was implemented directly at the community level, as a bottom-up approach without formal government cooperation. However, this approach was not treated positively either by the government or by the target user families; hence, JDA decided to co-operate closely with the governments of Uzbekistan and Karakalpakstan for the implementation of the SODIS projects. This involved a long process of advocating SODIS at various levels of government where positive results of the health impact study (diarrhoea reduction 31.3–42.3 per cent) played a key role in shaping the decisions of the Ministry of Health to sign a three-year SODIS project agreement with JDA.

In many states of the former Soviet Union, NGOs are often viewed with suspicion and caution. An NGO can only implement project activities with the permission of the various government institutions, or else face serious legal problems.

At the beginning, JDA was coordinating the project, while the Ministry of Health was providing personnel and infrastructure. Later on, as the positive effects of SODIS in improving the quality of the microbiologically contaminated water were officially recognized, the health authorities became more active and their assistance increased, especially in the regions. This included joint decision-making about the planning process, selection of project sites and health personnel, and the reporting and monitoring structure.

A bottom-up approach without formal government cooperation did not work

In many states of the former Soviet Union, NGOs are often viewed with suspicion

Main issues and challenges

The approach taken by JDA was based on cooperating with the Ministry of Health of Uzbekistan as much as possible. JDA's key role was to build technical capacity and to advocate SODIS at all levels within the Ministry of Health. JDA established a large-scale SODIS implementation model and developed training and monitoring skills of health personnel, for the Ministry's administrative leaders as well as its doctors and nurses in the rural communities. Six regional project coordinators and 24 SODIS trainers are now technically competent in SODIS promotion to take the lead within the Ministry of Health.

JDA and the Ministry's Department of Epidemiology and Sanitation signed a three-year agreement to introduce SODIS in four provinces of the country. The project outcome depended heavily on the motivation and initiatives of the key officials in the field such as a high level of enthusiasm among the doctors. For instance, if they were convinced of SODIS and had seriously implemented the SODIS dissemination process, the acceptance rates in their regions were high, and a significant reduction of water-borne diseases could be measured. If they were doubtful or tried to avoid additional work responsibilities, progress was slow and results were rather disappointing.

A key issue was to keep regular and good communication between the various partners in the project. The monitoring and supervision of the field implementation was challenging, as distances were large and communication lines limited. Further, the health staff were used to writing rather over-optimistic reports which required additional training on how to report field progress accurately and honestly.

Lessons learned

The formal cooperation with the Ministry of Health on a national level gave the SODIS method much credibility and trust. Therefore, JDA was spared many of the obstacles faced in the pilot phase that was implemented without government cooperation.

People in the former Soviet Union are used to following orders from above, while being rather suspicious of foreign ideas. In this regard, a formal agreement with the Ministry of Health was very important to overcome this challenge. For instance, when some health administrators in the regions mistrusted SODIS, as a new method and wanted to stop the project, the formal agreement with the Ministry prevailed. Further, as they obtained positive results on SODIS efficiency in disinfecting microbiologically contaminated water from their own laboratories, their scepticism declined.

The target users in the rural communities accepted SODIS more easily when introduced by their respected, well-known health workers

The project outcome depended heavily on enthusiasm among the doctors

The target users accepted SODIS more easily when introduced by their respected health workers

than by the staff of JDA, a foreign-based NGO. This approach transferred ownership into local hands in a short time period.

The Ministry of Health maintains health posts in almost all rural communities in the country. Disseminating SODIS through the existing, well-structured health system, the method reached a large number of users efficiently in terms of time and cost. SODIS was introduced and taught to almost 40,000 households within a year. This impact is far beyond the capacity of a small NGO like JDA.

A critical factor for sustainability of the project is the availability of funds. JDA was providing additional income to the selected trainers and funded training material, but did not hire all these health workers. This enabled JDA to use funds efficiently by complementing what the government failed to cover. To see long-term success of the project, it is, however, important that the Ministry of Health owns it and allocates an annual budget to SODIS dissemination activity in future. Although more time is needed for a complete transfer of ownership at various levels of the Ministry, a good foundation has been laid and the process of owning the project has begun. The Ministry of Health has developed in-house technical competence and is familiar with the SODIS dissemination model for a wide-scale implementation through the existing health system. In this regard, the prospect of continuing SODIS dissemination to combat water-borne diseases in the rural communities of Uzbekistan is promising.

It is important that the Ministry of Health allocates an annual budget to SODIS dissemination

Case II: Scaling up through the NGOs

LEAD in brief

League for Education and Development (LEAD) is an NGO based in Trichy, Tamil Nadu, South India. Its main objective is to empower women through health and hygiene education, self-help groups and microfinance services. Advocacy work at local authority level and networking with other NGOs is an integrated part of LEAD's activities. LEAD implements field activities primarily through *sangams* (women's self-help groups) which is also the SODIS dissemination structure at the community level.

The structure of most of LEAD's SODIS projects is based on *sangams*, where SODIS is introduced during group meetings or by field staff using door-to-door visits. As *sangams* are already existing structures for micro-credit programmes, and health and hygiene is an ongoing project, SODIS could be smoothly incorporated to complement the ongoing programme activities. Regular use of the SODIS method by the visible *sangam* member has a positive effect on the other members of the communities, thereby fostering adoption of the SODIS method (Moser et al., 2005).

LEAD introduces SODIS at the meetings of *sangams*, women's self-help groups

LEAD's approach to scaling up is based on cooperation with other selected NGOs

Scaling-up process through the NGOs

LEAD's approach to scaling up SODIS dissemination in Tamil Nadu is based on cooperation with other NGOs. Hence, identifying reliable partners is crucial for a successful outcome. Regarding appropriate partner selection, LEAD applies a set of selection criteria (ongoing health and hygiene programme in the communities; active and well accepted in the communities; and interest in the promotion and dissemination of SODIS) to identify potential local partner NGOs and then negotiates the number of target beneficiaries to be covered, time and fund requirements. Thereafter, the partner NGOs develop detailed work plans, assigning the required number of personnel to the SODIS activity who attend a SODIS training course conducted by LEAD. SODIS dissemination, follow-up of the user families and the monitoring are done by the NGOs while LEAD is responsible for the review and evaluation of the projects.

In Tamil Nadu, the SODIS method has been introduced to both rural and urban areas. In addition to disseminating SODIS in the peri-urban slums of Chennai and Trichy, parts of six rural districts have been covered and local PET bottle supply schemes have been established in the rural villages. Since 2002, LEAD and its partner NGOs have reached about 84,000 families out of which about 47,000 families are using the SODIS method daily. In Chennai, the four partner NGOs have covered 13,834 families and about 7,470 families are using the SODIS method daily.

Main challenges

LEAD has limited access to influence the partner NGOs' activities

In this approach, LEAD has limited access to influence the partner NGOs' activities, as the monitoring of field implementation is done by the NGOs. Although there is an opportunity to suggest changes or improvements during the monthly review meetings, successful implementation cannot be ensured. The risk is particularly high when a partner NGO is not performing well: for example if a follow-up is done only half-heartedly and the suggestions offered by LEAD are not implemented in time. In a yearly project, the evaluation of the partner NGOs is often done toward the end of the project when it is too late to improve the deficiencies in field implementation.

Although LEAD has a good reputation, it is difficult to expand beyond the regional level because of the vast cultural and language differences. In addition, tensions between NGOs working in the same field and their territorial behaviour prevent smooth cooperation. On the other hand, the local NGOs are site-specific and working in small areas; hence, they have limited capacity to reach a larger population despite the great need for SODIS and good acceptance by the user families.

A short-term contract will adversely affect the sense of ownership

Based on the funding cycle, these partner NGOs are contracted on a yearly basis and lack the long-term perspective that is required to develop ownership. Consequently, the SODIS activity is taken on as a temporary task of the partner NGOs and not sufficiently anchored in the ongoing programme. Further, these NGOs are dependent on external funding support and a short-term contract will adversely affect the ownership building process, thereby reducing the chances of sustainability.

Lessons learned

LEAD needs to improve the field monitoring of the partner NGOs through a jointly developed monitoring plan so that the field progress and challenges are analysed and appropriate measures are taken in time to enhance the quality of field implementation. Further, the local partner NGOs should initiate long-term plans to foster ownership of the SODIS project.

Working through local NGOs avoids government bureaucracy

Working through local NGOs avoids government bureaucracy allowing smooth implementation of the planned activities and better acceptance at user level due to the familiarity of the project staff with the local communities. However, implementation is focused on specific sites, thereby reaching a limited number of households.

Although the NGOs are certainly more reliable for SODIS promotion and dissemination, the SODIS promotion strategies need formal cooperation with large networks such as the government health and education system to reach large sections of the population that are without access to clean water.

Discussion

Table 1 compares different aspects of the two approaches.

A political decision of the Uzbek Government banned all foreign NGOs including JDA

The poor level of scaling up with JDA is apparent from Table 2, as expected for two reasons. First, there was a shorter implementation time, as only three phases were implemented compared with LEAD's implementation of five phases. Second, in 2006 a political decision of the Uzbek Government banned all foreign NGOs working in the country including JDA. Consequently, JDA had to close when it was preparing for nation-wide scaling up following the signing of a formal agreement with the Ministry of Health. Hence, the scaling up comparison between LEAD (working with NGO) and JDA (working with government) is not representative. Instead, LEAD could be compared with CAP, another organization that is working with the government for scaling up SODIS dissemination in Pakistan for the same time period.

Table 1. Comparing the two approaches

<i>Project parameters</i>	<i>Implementation through government</i>	<i>Implementation through NGOs</i>
Advocacy	Requires an effective and persistent effort to influence the policy level decisions to initiate a test project and finally incorporate the method into the ongoing programme	Not necessary, as the discussion directly starts with the project planning
Setting up operation	Complex bureaucratic process that takes several months for the final approval	Directly at project planning, hence, simple and fast
Trust on information and dissemination	High trust on the information disseminated through government health system. A good access for country-wide dissemination: infrastructure, human resources and mass media	Trust on the information depends on the personal relationships of the NGOs with the target communities. Information dissemination is limited to project sites, as the use of mass media is expensive
Field implementation	Focus on building technical competence of the government staff, monitoring for quality implementation and assessments	Build the technical competence of the local NGOs while monitoring and assessment may be done by the partner organization
Impact (number of people reached)	Has the potential to cover a large population	Small and limited to project sites with little dissemination outside the project
Ownership (commitment to continue)	Aims to own the project, as SODIS is incorporated into regular government programmes	Questionable ownership, as SODIS is not institutionalized and remains a time-limited project activity
Sustainability of SODIS dissemination	High chance of sustainability, as the government is more likely to allocate an annual budget once SODIS is mainstreamed into public health programmes	More likely to discontinue, as the external funding support for the project phases out

Table 2. Comparing scaling up between the two approaches

<i>Parameters</i>	<i>Number of trained SODIS trainers</i>	<i>Number of households trained</i>	<i>Number of households practising SODIS</i>	<i>Remarks</i>
LEAD, India (working through NGO)	600	84,208	47,205	5 Phases
JDA, Uzbekistan (working through government)	1,400	44,072	16,325	3 Phases Project closed
CAP, Pakistan (working through government)	2,995	485,652	99,828	5 Phases

Following on from the closure of JDA's programme in Uzbekistan, one of the authors can report that in 2007 the Ministry of Health did not continue the programme, but some of the provinces have kept going at a local level on a limited scale.

Although both organizations, LEAD and CAP, have completed five phases of project implementation, there is a significant difference in the three parameters. In the case of CAP, the number of trained

There may be higher potential for scaling up through a government agency

A proper monitoring plan is needed to maintain the implementation quality

SODIS trainers is five times higher, the number of households trained is nearly six times higher and the number of households practising SODIS is twice as high as that of LEAD. This clearly shows higher potential for scaling up through a government agency.

Lessons learned

NGOs are ideal partners to create an environment and facilitate the scaling-up process with large organizations such as the health agency within the country. This holds true in the case of CAP (Pakistan), ENPHO (Nepal) and AU (Assam, north-east India).

During scaling up with large organizations field monitoring and data collection are challenging; hence a proper monitoring plan is needed to avoid misunderstanding and maintain the implementation quality. For instance, insufficient consultation between CAP and the collaborating government health programme in Pakistan created a challenge in field monitoring and data collection.

A further lesson is that long-term planning is needed for scaling up through NGOs, as they are dependent on external funding and likely to discontinue after a one-year project phases out.

Although scaling up through NGOs is a relatively simple process, both the networking and sustainability of the dissemination process is limited. In contrast, scaling up through government is complex and demands more time and effort. However, the impact can be large and is more likely to be sustainable, although a longer time frame is required to accomplish the entire process effectively.

Scaling up through government enhances the credibility of the SODIS information disseminated to the target population; hence, a higher chance of project success. For example, in Nepal and Pakistan disseminating SODIS through a government health programme enhanced people's trust in SODIS resulting in better acceptance by the user families.

Recommendations

- The pilot phase needs careful planning in order to generate reliable results: the health impact and people's acceptance of SODIS are essential to pursue effective advocacy at the policy level with the government.
- NGOs should lead the pilot phase and, thereafter, engage in advocacy and training of government staff to enhance their technical competence and, hence, create an environment to incorporate SODIS into ongoing programmes.

Box 1. The experience of SODIS promoters

The SODIS promoters play a key role in the SODIS dissemination process in both cases: working with NGOs or with government. Staff such as field-level health workers act as SODIS promoters in the case of working with government while selected and trained local individuals perform the task of SODIS promoters in their communities. An ideal SODIS promoter should have some leadership qualities, should be socially accepted, good at communicating information, have the patience to listen to criticism/scepticism and handle it comfortably, have sound technical knowledge and should practise SODIS at home. A female promoter is preferred, as SODIS dissemination primarily deals with women in the communities. They conduct group training for user families and thereafter make routine follow-up visits to ensure that the trained user families are able to practise SODIS correctly for at least 4–6 weeks to establish this new habit in the daily household chores.

Some of the challenges frequently faced by the SODIS promoters in the field are shortages of PET bottles, incorrect application of the SODIS method, lack of trust in the method especially from male members of the community who have not attended SODIS training, and medical practitioners. Having adequate PET bottles (at least 2 litres per person) is an important factor in SODIS use and often the reason for not starting to practise SODIS is attributed to PET bottle shortages. In addition, the SODIS method is not visible; this makes it difficult for the people to comprehend the disinfection process. Besides, the simple process and reuse of PET bottles raises scepticism that the method is of low quality and intended for poor people. Another significant group that tends to distrust the SODIS method is medical professionals and their advice against its use could damage the reputation of SODIS. For instance in Nepal in 2004, a doctor unaware of SODIS had advised his patient to stop using SODIS and to drink only boiled water. The news quickly spread in his community and everybody stopped using SODIS. To repair the damage, ENPHO (the SODIS promoting organization in Nepal) explained the SODIS method to the doctor and brought him to a community meeting where he advised the people that SODIS water is good for health. Hence, a SODIS promoter should be technically competent and socially able to effectively address the challenges especially during the early stage of the project.

Sometimes medical professionals mistrust SODIS and advise against its use

Partners should be selected which have large networks

- One of the key criteria for partner selection should be organizations with large networks that have potential to reach a large population and have health, hygiene and safe water components.
- Institutionalization of SODIS into regular government health and education programmes should be the main aim of the scaling-up phase to ensure the sustainability of SODIS dissemination.
- The scaling-up phase should have a 4–6 year time frame to complete the field activities successfully.

Conclusions

As the main aim of the SODIS project is to introduce the method to a large number of people with limited access to clean drinking

Scaling up through NGOs is more suitable in peri-urban slums where the presence of the government is limited

water, scaling up through a government agency is more relevant. The role of the partner NGO is instrumental in piloting, advocating and training the government staff to develop technical competence and incorporate SODIS into regular health and education programmes. In addition, the institutionalization process involves complex bureaucracy and, hence, requires a longer project time frame of 4–6 years to accomplish the entire process successfully.

Scaling up through NGOs is more suitable in densely populated informal settlements of the peri-urban slums where the presence of the government is limited. Comparing the two approaches in relation to disseminating the SODIS method to a large number of people and its sustained use, approach I – working through the government – is more effective. The SODIS projects in Uzbekistan and Pakistan have covered large areas and populations through the existing government health networks, compared with approach II – working through the NGOs – where implementation was confined to the project areas of the partner organizations, as was apparent in the cases of LEAD, South India, KWAHO, Kenya, CCS, Kenya, and ADRA, Cambodia. However, the role of partner NGOs was very important in guiding the government agencies to implement SODIS effectively.

In terms of sustainability, streamlining of SODIS into national health and education programmes is more effective than implementing through partner NGOs, which are dependent on external funding support.

References

- Acra, A., Karahagopian, Y. and Raffoul, Z. (1980) 'Water disinfection by solar radiation', *Lancet* II: 1257–8.
- Acra, A., Raffoul, Z. and Karahagopian, Y. (1984) *Solar Water Disinfection of Drinking Water and Oral Rehydration Solutions: Guidelines for Household Application in Developing Countries*, UNICEF, New York.
- Berney, M., Weilenmann, H.U., Simonetti, A. and Egli, T. (2006) 'Efficacy of solar disinfection of *E. coli*, *S. flexneri*, *S. typhimurium* and *V. cholerae*', *Journal of Applied Microbiology* 101: 828–36.
- Conroy, R.M., Elmore-Meegan, M., Joyce, T.M., McGuigan, K.G. and Barnes, J. (1996) 'Solar disinfection of drinking water and diarrhoea in Maasai children: a controlled field trial', *Lancet* 348: 1695–7.
- Conroy, R.M., Elmore-Meegan, M., Joyce, T.M., McGuigan, K.G. and Barnes, J. (2001). 'Use of solar disinfection protects against cholera in children under 6 years of age', *Arch Dis Child* 85: 293–5.
- Hobbins, M. (2003) *The SODIS Health Impact Study*, PhD thesis, Swiss Tropical Institute, Basel, Switzerland.

Joyce, T.M., McGuigan, K.G., Elmore-Meegan, M. and Conroy, R.M. (1996) 'Inactivation of fecal bacteria in drinking water by solar heating', *Applied and Environmental Microbiology* 62(2): 399–402.

McGuigan, K.G., Joyce, T.M., Conroy, R.M., Gillespie, J.B. and Elmore-Meegan, M. (1998) 'Solar disinfection of drinking water contained in transparent plastic bottles: characterizing the bacterial inactivation process', *Journal of Applied Microbiology* 84: 1138–48.

Moser, S., Heri, S. and Mosler, H.J. (2005) *Determinants of the Diffusion of SODIS: A Quantitative Field Study in Bolivia. Summary Report*, Eawag, Duebendorf, Switzerland.

Ramteke, P.W., Pathak, S.P., Bhattacharjee, J.W. Gopal, K. and Mathur, N. (1994) 'Evaluation of the presence-absence (P-A) test: A simplified bacteriological test for detecting coliforms in rural drinking water of India', *Environmental Monitoring and Assessment* 33: 53–9.

Reed, R.H. (1997) 'Solar inactivation of faecal bacteria in water: the critical role of oxygen', *Letters in Applied Microbiology* 24: 276–80.

Rose, A., Roy, S., Abraham, V., Holmgren, G., George, K., Balraj, V., Abraham, S., Muliylil, J., Joseph, A., and Kang G. (2006) 'Solar disinfection of water for diarrhoeal prevention in Southern India', *Arch Dis Child* 91(2): 139–41.

Sommer, B., Mariño, A., Solarte, Y., Salas, M.L., Dierolf, C., Valiente, C., Mora, D., Rechsteiner, R., Setter, P., Wirojanagud, W., Ajarmeh, H., Al-Hassan, A. and Wegelin M. (1997) 'SODIS: An emerging water treatment process', *Journal of Water Supply, Research & Technology–AQUA* 46: 127–37.

Wegelin M., Canonica, S., Mechsner, K., Fleischmann, T., Pesaro, F. and Metzler, A. (1994) 'Solar water disinfection: scope of the process and analysis of radiation experiments', *Journal of Water Supply, Research & Technology–AQUA* 43: 154–69.