Chapter 2
Theory and Context

2.1 Introduction

Appendix 10 provides a summary of the major conferences and Summits held with regard to the wider issues of development of the living and environmental conditions of the world's poor, developing and developed countries. Section 1.2 discusses the main points recognised, and the lessons learned since Stockholm 1972, highlighting that all the various issues connected with development are complex and thus it is not possible to work with a single overarching theoretical model of sustainable development. Further, it stressed that in order to achieve concurrently, social, political and ecological changes in the real life settings of the end-users of development projects, anyone active in the field must consider much broader approaches than previously applied.

Though it is not often spoken or explicitly written about, there is a close connection between technical and environmental development projects and health improvement of the beneficiary community. However, most of the development activities and projects address improvement of people's health and living conditions, which also improve health, well being and the physical condition of individual people as well as whole communities. Therefore it is justified to say that technical projects can be considered as well to be active preventative health care measures.

Initially, when the concept of "primary health care for all" emerged in the 1970s, as a concept, it was integrative and multi-level. WHO gave health the holistic meaning of "the physical, mental and social well being of the individual" (Alma Ata 1978). With its "Health for All by the Year 2000" initiative, the WHO sought to ensure that "as a minimum, all people in all countries should have at least such a level of health that they are capable of working productively and of participating actively in the social life of the community in which they live" (Rifkin and Walt 1986, 561). Projects inspired by this thinking were multi-pronged, aimed at, for example, decreasing diarrheal disease by improving hygiene and sanitation with infrastructure improvements to drinking water supplies. At that time it was axiomatic among community development professionals and theorists of development that projects should be holistic, multi-pronged, and involve the efforts of a multi

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disciplinary team, acting in concert with local people. Later, due in large part to shifting economic conditions and a greater emphasis by donor agencies on quantifiable results and outcomes, a more narrow definition of primary health care emerged. This definition is often associated with the somewhat contentious "selective approach", discussed later. Thus, the emphasis on multi-pronged projects fell by the way side in the 1980s and 1990s, when international funding for development aid came under increasing scrutiny, and the scope of projects narrowed in order to meet ever tightening control over reporting and transparency, and an overwhelming need to show results—preferably within one fiscal year.

Though selective approaches to development (projects with only single components such as indoor lighting or a village drinking water system) are effective in achieving carefully de-limited goals, selective approaches cannot produce the critical synergistic benefits of a multi-pronged, holistic project framework.

In the 1970s the concept of primary health care began to occupy the world's attention. The WHO published a crucial document in 1973 called, "Organisational Study on Methods and Promoting the Development of Basic Health Services" (Perpich 1975; UN 1997; WHO 2008), in which it laid out some of the main issues. It identified the fact that the roots of the health services crisis facing the developing world did not lie exclusively in the domain of the health sector. Instead, the authors recognised that health had to be situated in a social and economic context and that political structures and priorities had to be considered as well.

This was the climate out of which the Alma Ata conference in 1978 developed. Holistic community development as a strategy for improving health outcomes emerged in a period during which there was significant debate about the nature of poverty and the need to understand the structural changes that would be necessary to improve the lives of the impoverished. The foundation of this approach relied upon the idea that improvements in health would always be contingent in part upon changes in the social, political and economic factors that ultimately determine the quality of life of the World's poorest.

2.2 Comprehensive Approaches to Community Development

Advocates of a comprehensive or holistic approach to improving livelihood and health emphasised the fact that many issues affect health (Magnussen et al. 2004). The focus was on the fact that in most project sites in the rural developing world, the physical infrastructure (lack of roads and bridges), the absence of running water and electricity, the difficulties associated with getting people to accept and use such innovations as latrines, improved cooking/heating stoves, and lack of transport (among many other social and economic factors) all affect health outcomes. According to this assumption, the assistance of a variety of professionals in broad, multi-sectoral programs to improve health status in a target population was considered necessary. Health was viewed not simply as a problem of disease but one of several factors contributing to lower the quality of life that the poor experience. Some examples of comprehensive primary health care programs would include projects that improve health awareness and training, community public health education, improved access to affordable energy services, drinking water taps, capacity to grow more nutritious food, improvements in the safety and cleanliness of living areas, building health posts and furnishing them with staff, supplies, and on-going training.

It is important to situate this approach in its appropriate historical context. Until the 1980s there was a strong sense of optimism in discussions and debates about international development. The world economy was growing and the social climate, particularly in the late 1960s and 1970s was favourable for projects that emphasised holism, community, and social equality. Investments in international development were high and expected to continue increasing. Multi-sectoral, broad based comprehensive primary health care was "in".

Fast forward a few years to the 1980s. The world economy looked very different—economic recession, debt, the oil crisis and an increasingly unfavourable trade climate had taken their toll, and the world economy was not growing as hoped. Development projects across sectors had failed and many people had lost confidence in the process of international development. Projects focused on health were particularly concerning to analysts of development, because the possibility that health was not a development sector that was going to be able to be "turned over" to some governments in the developing world any time in the next 50 years was beginning to be understood (LaFond 1995). As LaFond (1995) notes, weakening public support for overseas assistance in the 1980s strongly affected international donor agencies' budgets to programs that could not show "results". Health focused UN agencies (e.g., UNICEF) and the WHO were affected by heightening public scrutiny and criticism as well, and were increasingly governed by the need to show results that were simple to display, easy to understand, and obtainable within a defined funding cycle (often only 1 year). This dramatically changed the nature of the projects that were promoted and funded.

2.3 Hard to Measure and Lacking "Results" Triggers Donors' Response

As donors became aware of the complexity of the problems affecting health outcomes, they were also realising that it was difficult to measure immediate health impacts for many of the components of the holistic community development programs that had been initiated in the 1970s. For example, it is difficult to measure the short-term health impact of a water tap system, because although it may improve hygiene and sanitation initially, other factors can intervene and depress the benefits of these improvements on health. In response to the perception of these measurement and assessment problems, many agencies started to scale back in the nature and scope of the programs in which they invested.

Thus emerged selective primary health care, an approach that "espoused the mobilisation of health services to attack the most prevalent disease problems" (Rifkin and Walt 1986, 562). It is centred on short-term, single-goal oriented interventions, and cost effectiveness. Vaccination programs are an example of this approach. These are simple, effective and affordable interventions that prevent devastating, often fatal diseases experienced by many of the rural poor (e.g., measles, pertussis, tetanus, poliomyelitis, diphtheria and tuberculosis). The hallmark of the selective primary health care approach is UNICEF's "GOBI" program. GOBI[1] is an acronym for Growth monitoring, Oral rehydration therapy, Breastfeeding and Immunisation. These are four medical interventions that well-exemplify the selective approach: they are simple, low technology, single-sector, quantifiable interventions thought to have a low cost, high impact effect on child survival. GOBI was part of the much touted "Child Survival and Development Revolution". A quote from a UNICEF official illustrates the appeal of Child Survival and the GOBI approach:

> The disastrous consequences of the recession prompted UNICEF to re-examine its work with a view to exploring and reordering its priorities at times when resources are limited amidst increasing demands and needs. This led to the adoption of low cost, high impact measures which would contribute to child survival and development…and [are] viewed as the core of a cost effective and high impact programme (quoted in LaFond 1995, 26).

Unger and Killingsworth (1986) assert that in the mid 1980s, selective primary health care was the darling of bilateral co-operation agencies, foundations, academics and research institutions, and international agencies. They suggest that "rather than health factors, the major determinants of this adoption have been political and economical constraints acting upon decision makers" (Unger and Killingsworth 1986, 1001).

2.4 Lessons from the Field

Comprehensive primary health care is fairly well studied, and available studies allow us to identify the approach's successes and weaknesses. A review of the impact of a variety of interventions under the comprehensive approach, suggested that the evidence for the impact of community based health care programs in poor countries on the mortality rates of young children is weak (Ewbank and Gribble 1993).

More recently, a study was conducted in the Gambia that analysed the influence of village level primary health care on mortality rates in children (Hill et al. 2000). The Gambian study compared mortality rates over 15 years among 40 villages. All of the villages had access to maternal and child health programs and vaccinations from a local health centre, but only some of the villages had primary health care. Primary health care was defined as the presence of one paid community health

[1] The website for more information about the UNICEF's GOBI program can be found at: http://rehydrate.org/facts/gobi-fff.htm. Accessed 26 July 2012.

nurse for approximately every five villages, in addition to a village health worker and a trained traditional birth attendant.

During the 15 years studied, funding and support for the primary health care program grew, was maintained, and then dropped. The authors found that while the primary health care program was well funded and supported, the mortality rates of 1–4 year olds were significantly lower in the villages with primary health care. For children ($\geq$5 years old), the results were less clear cut, though for both age groups, mortality rates rose after support for the primary health care staff weakened (Ewbank and Gribble 1993; Hill et al. 2000).

Other analyses of specific community based interventions aimed at improving hygiene, sanitation and indoor air quality show that the introduction of certain technologies brings positive results and can have a strong effect on improvements in health, as described below.

Indoor air pollution (IAP) kills one person every 20 seconds in developing countries (Warwick and Doig 2004), and there is no doubt that IAP contributes to the incidence of respiratory disease in the villages where the author works. Reductions in IAP are known to be very effective in improving the health status of people, particularly among women and children under the age of five. The many negative health effects of excessive IAP are well understood (Smith et al. 2000), and the health benefits of transitioning from heating and cooking methods that produce heavy IAP loads to cleaner methods have been documented. Ezzati and Kammen (2002) estimate that in their study population in rural Kenya, interventions that reduced IAP, caused a reduction in acute upper respiratory infections by 24–64 %, and acute lower respiratory infections by 21–44 %.

Through RIDS-Nepal we conduct 24 hours IAP tests in Humli households with traditional, smoky lighting and open-fire cooking/heating systems (Figs. 2.1 and 2.3.). In homes with the RIDS-Nepal solar PV systems and smokeless metal stoves (Fig. 2.2), the TSP, PM_{10}, $PM_{2.5}$ and CO values[2] were much lower, thus showing that these technologies improve indoor air conditions very significantly. Following solar lighting and smokeless metal stove (SMS) installation, households had IAP levels measured[3] that were 10–50 times lower than the levels we measured[4] in traditional, open-fire conditions. This was true for all measured values, including TSP, PM_{10}, $PM_{2.5}$ and CO values. Preliminary analyses of this health data suggest that this reduction in IAP has substantially reduced the incidence of symptoms of respiratory disease.

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[2] TSP stands for "Total Suspended Particles" and includes all particles suspended in the air generated by a polluting source. PM_{10}, $PM_{2.5}$ are particulate matter of <10 or <2.5 μm (micrometres) in diameter and thus able to enter the respiratory system. CO is carbon monoxide.

[3] Since 2006, RIDS-Nepal has used an EPAM-5000 Environmental Particulate Air Monitor to measure the $PM_{2.5}$, PM_{10} and TSP indoor air pollution. This portable EPAM-5000 includes a gravimetric and photoelectric detector. http://www.hazdust.com/epam5000.php. Accessed 26 July 2012.

[4] These average improved IAP levels are based on the RIDS-Nepal's recorded (unpublished) measurements in over 50 households. Each IAP test is over a 24 h time period over the years 2006–2010, in homes without and with the installed smokeless metal stove over the years 2006–2010.

Fig. 2.1 “Odhan”, an open-fire place with three stones or a simple three footed iron holder is the traditional cooking technology used by all family households in Humla, creating enormous health hazards through very high indoor air pollution

Fig. 2.2 With the smokeless metal stove, up to half the firewood can be saved, food is cooked all at one time and the indoor air is clean

Other interventions including safe stool disposal have been shown to be effective in reducing diarrheal disease rates (Tables 7.3, 7.4 and 7.5). A study of domestic hygiene and diarrhoea in Bangladesh showed that post neonatal mortality rates were 68 % lower in families with latrines than in those without (Rahaman et al. 1985). Gorter et al. (1998) showed that Nicaraguan families with children whose faecal matter was properly disposed of by using diapers were at reduced risk of diarrhoea compared with those families in which children went without diapers.

Fig. 2.3 Previous to the elementary indoor lighting the use of "*jharro*" (a resin soaked pine wood tree stick) was the traditional way of generating a dim, smoky indoor light

Hand washing after defecation has been found to be uncommon among people in the developing world (Han et al. 1986; Huttly et al. 1994). In order to wash effectively enough to prevent disease transmission, one study in Guatemala found that mothers had to wash their hands an average of 32 times per day, using an additional 20 liters of water (Graeff et al. 1993). A review of studies of hand washing suggests that "the promotion of hand washing with soap is an intervention that appears to be both highly effective, reducing diarrheal incidence by between 27–89 %, and feasible" (Curtis et al. 2000). The ability of people to wash their hands frequently and effectively depends upon readily available water, which is a significant problem for many poor communities.

Potable water is often thought to be absolutely critical in preventing diarrheal disease. However reviews of 67 studies in 28 countries in 1986 and another 17 studies in 1991 "concluded that improvements in water availability were probably more important than in water quality" (Curtis et al. 2000, 27). In fact, it appears that the health effects of having clean (drinking and cooking) water are swamped by the benefits associated with having enough water to increase hygiene and sanitation practices, in particular dishwashing and hand washing.

Flies have been linked to diarrheal incidence in a number of studies. One study of Israeli soldiers demonstrated a significant reduction in diarrhoea when yeast baited fly traps were introduced (Cohen et al. 1991). Another study showed that spraying insecticide was effective in killing houseflies and reduced the incidence of diarrhoea by nearly 25 % compared to villages where the insecticide was not sprayed (Emerson et al. 1999). Unfortunately, control of flies in a village setting is extremely expensive and difficult. However, safe stool disposal is an achievable goal. Preliminary analysis of our data shows a reduction in the incidence of diarrhoea in villages where pit latrines have been built, which is believed at least partly attributable to reductions in the probability that flies are contacting stool, which would limit disease spread.

Many studies have shown some effect of a variety of interventions falling under the umbrella of comprehensive primary health care. However, measuring the effects on health of some of these interventions can be very difficult, particularly on short time scales. This is because the negative effects of other problems that the target community faces can cancel out the health effects of any one of these interventions. Thus, measurement of the benefits of comprehensive programs has to be extremely careful and for validity must also be compared with controls.

2.5 Comprehensive Versus Selective Approaches Needs in Humla, Nepal

The author's practical experience over 16 years in the field has convinced him that a selective approach alone cannot effectively and responsibly improve the livelihood and health outcomes of Humli people. Currently, it is widely recognised that acute respiratory infections (ARIs), diarrheal diseases and malnutrition are the main problems that need immediate and sustained attention in rural Nepal (Winrock 2004; Benguigui 1999; Pandey et al. 1989b). These problems cannot be addressed without making deep and significant changes to infrastructure and behaviour patterns. While selective projects, targeting diseases like polio and measles are critical, and do show results that are easily quantified, they cannot be the only approach to tackling the serious health problems facing Humli people in the struggle for improved overall living conditions. A study in central Nepal, of interventions aimed specifically at reducing ARIs, showed a 60 % drop in ARIs with education, immunisation and antibiotic treatment of children showing signs of pneumonia, but the authors concluded that this reduction was overshadowed by the still unacceptably high rates of mortality from the other killers, primarily diarrhoea, and malnutrition (Pandey et al. 1989a). Despite the fact that this realisation may be shared by other people in the development field, project models still tend not to be as holistic as the author recommends.

In our time in the villages, we have seen positive synergistic effects of holistic community development programs, when project components are chosen by villagers based on their needs assessment and when these components dove tail together to improve the overall hygiene, sanitation and access to elementary energy and health services in the village. Factual data with regard to synergistic benefits are very difficult to obtain and sort out, particularly in regard to their source, magnitude and quality. This is because most benefits are related to long-term improved living conditions and increased preventative health care from the various, concurrent projects and these changes are hard to identify and express in merely numerical terms. Further, changes need to be tracked and observed over a long time period. However, the author and RIDS-Nepal have gathered many anecdotal testimonies, shared by the end-users. They include statements such as: "since the SMS has been installed, the women and children of the homes have been freed from their chronic coughs and chest pains as well as their previously resilient eye infections and heart pains"; "The pit latrine each family has built as a precondition for an SMS has enabled the whole village to become much cleaner and more hygienic"; "The people, and in particular the children, experience far fewer cases of diarrhoea with the consequent dehydration, loss of valuable nutrients, subsequent weakness and inability to work or learn".

These improved health conditions, in combination with the basic indoor lighting, enable the women and out of school children to participate in the daily NFE classes. To be able to read and write, along with the basic numeric skills, brings invaluable long-term personal as well as community benefits, which would have not been possible without the HCD approach.

This is what inspires us to continue to improve upon a model we call the "Family of 4" and to expand it into the "Family of 4 PLUS" over the years. The outline of this approach was originally designed by the author in 2000 after having worked with, and lived among the local communities for over 4.5 years. Over the years the author and his team have developed, improved upon and added new project components, based on participant observation and direct consultation with villagers. We find that the empowerment associated with the teaching/learning, equipment ownership, and project design and implementation uplifts individuals and groups of individuals within the village in a fashion that could never be achieved by a selective approach to improving overall living conditions and health outcomes (Zahnd and Malla 2006). This experience has convinced us that a return to holistic community development, with projects designed after detailed needs assessment is conducted in concert with villagers themselves, is not only good and successful; it is imperative. Further, history has brought forth example after example of development projects worldwide which have demonstrated that local people have to grow into technological and subsequent behavioural changes slowly, for the simple, and perhaps obvious—but rarely admitted—fact that traditions and cultures change much more slowly than new technologies can be introduced (Zahnd and Haddix 2007b, c). Therefore, the newly developed HCD concept is set in a time frame of two generations, during which the various projects are defined, implemented and followed-up. This reflects about a 20 year time span in the present context of Humla.

It is crucial to understand that the local community is at the centre of any holistic development project and that the technologies applied are to serve and support their struggle for a better life. Therefore, any project has to be based on a thorough understanding of the local context and culture, and must include an understanding of the "invisible" causes of poverty, and the impact on the community of decades of deprivation. This approach demands time, compassion and dedication. These more "human" aspects of a development project are crucial factors that need to go alongside the technical aspects. In this way the people are recognised from the beginning as equal partners and not just as receivers of imposed ideas. This time intensive, often frustrating process is central to a holistic development project.

2.6 The Role of Renewable Energy Technologies in HCD

Almost all of the identified 1.6–2 billion people without access to electricity (Mills 2002), 1.1 billion without safe drinking water, 2.3 billion suffering from water related diseases (with over 2 million children dying each year), 2.4 billion without adequate sanitation (TEAR 2002) and 2.4 billion relying on traditional biomass for their daily energy services (IEA 2002), live in developing countries, and four out of five live in rural areas (IEA 2002). Lack of electricity and heavy reliance on traditional biomass are hallmarks of poverty in developing countries (IEA 2002). Deforestation in Nepal is widespread and the once picturesque, biodiversity rich forests and valleys are stripped of their valuable resources in unstainable ways.

Today, over 100 years after Edison's visionary statement that: "we will make electricity so cheap that only the rich will burn candles" (Mills and Johnson 2002), this is only true for the industrialised countries. More people today do not enjoy the luxury of having light in their homes in the developing world than the world's population in Edison's time.

There is a clear relationship between poverty and access to electricity (IEA 2002; Saghir 2005). Poverty levels increase the more remote and inaccessible the communities are, while costs for electrification increase due to transport and maintenance costs. It is also absolutely essential that projects are sustainable, locally appropriate, and are developed in close partnership with the local community. The availability of elementary energy services is a crucial agent of long-term community development. The author argues that tapping locally available renewable energy sources, through applied renewable energy technologies, developed for a defined geographical, cultural and climatic context, is central to project success. These technologies, in concert with the other contextualised project components described in this thesis, form the backbone of our holistic approach to community development.

Tapping into locally available renewable energy resources to provide the necessary energy services in appropriate, affordable and culturally sensitive ways, in conjunction with projects addressing health, food, hygiene and educational needs, result in synergistic benefits. The approach embraced in this collaborative effort between RIDS-Nepal, its donor partners and the local people, is that the combined outcome of a comprehensive community development project bears more sustainable benefits than the sum of each individual project. This is particularly true with respect to the four critical pieces of community development in remote Nepal: pit latrines, stoves, lights, and clean water, which the author calls the "Family of 4". We believe in the synergistic effect of a project such as the "Family of 4" and thus have created projects that energise villagers' faith in, and enthusiasm for, making the model work as a whole.

Approximately 75 % of Nepal's 26.6 million people live in rural areas, with around half of these so remote that neither a road nor the national grid is likely to ever reach them. While Nepal has no fossil fuel resources, it is a country that is rich in renewable energy resources such as hydro power and solar energy. These abundant and locally available renewable energy resources can be tapped into with locally developed technologies that the community has helped adapt to the local conditions.

Poverty has many faces, and cannot be defined simply with economic values and figures, as previously discussed. One clear way to improve upon this situation is to work toward providing people living in poverty with access to, and control over sustainable energy producing projects. It is widely accepted that "poverty alleviation and development depend on universal access to energy services that are affordable, reliable and of good quality" (Reddy 2002; Saghir 2005). Access to energy services is a key in satisfying the daily needs of human beings, and there are clear linkages between access to energy and reduced infant mortality and fertility rates and increased literacy and life-expectancy, as the WEA report explicitly illustrates (WEA 2000).

While links between health and access to energy are illustrated in the studies cited above, there is an important gap in household level studies of the role of renewable energy technologies in improving health status. Many authors have described the effect of reducing IAP for improving respiratory health (Ezzati and Kammen 2002), but most if not all of those gains relate to the introduction of stoves. As described above, the very substantial reductions in IAP we see in the homes in our project villages is attributable to the combined effect of changing both heating/cooking methods (with smokeless metal stoves) and lighting methods (with solar PV/pico-hydro systems).

The author would argue then, that for those people living in remote areas, far away from mainstream development and the national grid, renewable energy resources present some very promising opportunities. They can make clear and definitive headway towards improved livelihood and health outcomes for the whole family through improved access to energy services, if they are responsibly and sustainable utilised. It is also clear that local universities, such as Kathmandu University in Nepal, can play a vital part in the development of contextualised RETs, locally developed and adjusted for the geographic, meteorological and cultural conditions in which they will be expected to function. The author's reasoning is, that a RET is/can be called "contextualised" when its design has emerged after considering the end-users' energy service demands, their living conditions, economic power and ability to learn and apply new technical skills, as well as the long-term sustainability of the system.

2.7 Basic Village Electrification System for People in Humla

Humla is the most northern district of the Karnali Zone, which is part of Nepal's western regional development area. This Zone is isolated from the mainstream of Nepal's economic development initiatives due to its remoteness, and because it is the only Zone with no connection to a road. In fact, a 16 day walk from the next road head is required to reach Humla's district centre, Simikot. The alternative is to book a 1 hour flight in an old Twin-Otter from Nepalgunj, in the very south of Nepal at the border with India. This flight lands in Simikot, before 2012 on a gravel landing strip, but comes irregularly, depending upon the weather and the routine diversion of the air fleet to other parts of the country depending upon politics and business.

The entire Zone is known for its permanent food shortage, environmental degradation, low productivity, regular disease epidemics among people and livestock, a harsh and unforgiving climate, weak education system, negligible employment opportunities, severe gender inequities in workload, health and education, and a growing trend toward emigration.

Humla lies also 16 days walk from the next grid connection, in the most difficult terrain, with high, snow covered peaks, forests, wild rivers and a harsh climate, with freezing winters, stormy springs and the annual monsoon rain. In these circumstances just to think of the shear cost of a grid connection is prohibitive. These features help explain the dire living conditions in the villages of the Humla people where our projects are located. Here people's lives are marked by poverty and suffering that is almost untouched by the modest but significant development gains experienced elsewhere in Nepal.

Lighting is often the first use of electricity in a developing country, and people are willing to invest in home or village electrification once they understand the potential health improvements, the increased educational opportunities for their children, and the possible financial savings (Mills and Johnson 2002) for their families. Our anecdotal testimonies show, that women, the primary users and organisers of household energy, place a high value on improved energy services such as lighting and an efficient cooking and heating stove. Thus the most appropriate solution is embedded power generation, through the utilisation of the locally available renewable energy resources. The remoteness makes it obvious that non-renewable fuels (such as petrol or diesel for a generator) are not affordable, having almost quadrupled in price by the time they reach Humla, due to the transport costs. Thus it is the available renewable energy resources, such as the streams, the sun and the wind, which are feasible and sustainable resources for power generation.

When we think of the availability of power, we mostly think of the availability of electricity by the flick of a switch at any time, and for almost any kind of application, independent of the power demand. This is in part because we either live in a developed country, or in an urban place in a developing country where the power grid is a reality. In the case of Humla this will probably never be the case, as embedded power generation demands considerable financial investment and careful long-term planning. That is why, for a remote and impoverished end-user community, which never had the experience of power access in the form of electricity, the first step into that new realm of experience is often a basic village electrification system. This is a simple power generation system for a few, low power consuming, long lasting lights, such as WLED (white light emitting diode) lamps (Figs. 2.4 and 2.5), utilising the locally available renewable energy resource.

In recent years Remote Area Power Supply (RAPS) systems have become a very suitable and appropriate power generation approach for remote communities. A RAPS system is a power generation system that is clearly defined in its scope,

Fig. 2.4 WLED lamp (AC or DC) with 12 NSWP510DS diodes, consuming a total of 1.1 W. These WLEDs have a life-expectancy of >50,000 h, which is about 20 years for an average household's use

Fig. 2.5 Humli family in their main room with two WLED lamps. The lamps provide enough lighting for people to see one another and to do daily indoor tasks such as cooking, cleaning, socialising and school homework

capability and life expectation. It utilises either a single or several renewable energy resources—the latter case is called a hybrid system (Sect. 3.2.2).

The author's reading, practical and anecdotal experiences show that improved access to energy services is one of the main steps to the fulfilment of the Millennium Development Goals (MDGs). People do not want energy resources as such but rather the energy services they can provide through the exploitation and conversion of available renewable energy resources. Almost all of our local communities, with no access to modern energy services, identify lighting, cooking, heating and clean drinking water as their main needs for improved living conditions. We have noted that lighting, for brighter illuminance and cleaner indoor air conditions, for reading/ studying and socialising, is the energy service which ranks most often at the top of the wish list of people in Humla (Figs. 2.6, 2.7, 2.8 and 2.9). It often marks the first milestone on the path of a community's development towards an improved living standard. But, as the EnPoGe report (Cecelski 2002) also recognises:

> Rural electrification is generally the costliest and structurally the most loss making activity for power utilities. It mostly brings in micro consumers, which worsens the load factor, and [puts] politically sensitive pressure on tariffs (Madan 2003).

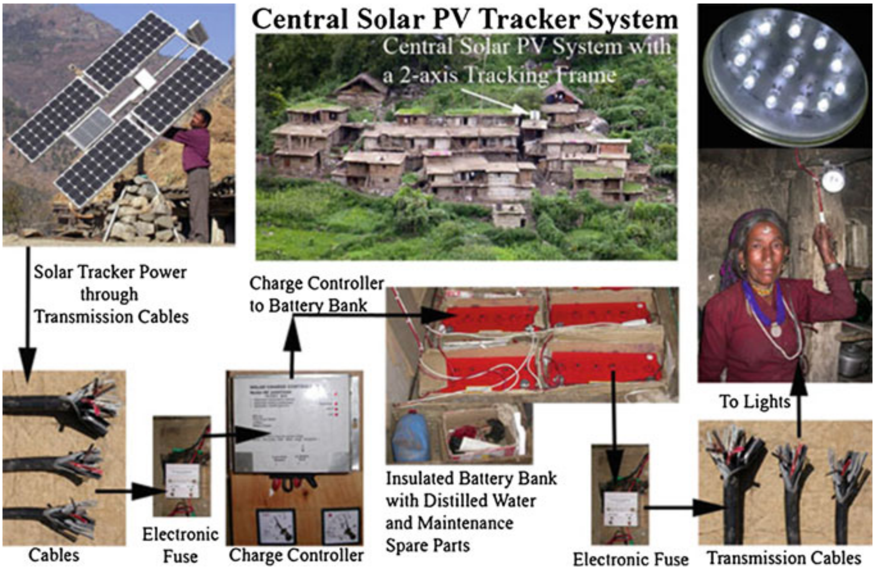

Fig. 2.6 RAPS system: The central solar pv village tracking system as installed in the village of Tulin in the RIDS-Nepal Humla project area (Sect. 3.3.2.3, Figs. 3.49 and 3.50)

Fig. 2.7 WLED lamps for minimal but locally appropriate, long lasting light services. Alongside is also an efficient smokeless metal stove, designed for the particular local cooking and heating needs, installed in each home

Fig. 2.8 Education is known to be a powerful tool in development, and benefits powerfully from the introduction of indoor lighting. Evening non-formal education classes can now be held

Fig. 2.9 Proud and participatory owner of a pico-hydro power plant. The community has chosen one of their own people to be specially trained to operate and maintain the pico-hydro power plant

This does not provide a good starting point to consider the electrification of the remotest and economically weak communities, living in some of the most hostile and inaccessible areas of the world. The worldwide trend to privatise utilities, to have electricity generation, transmission and distribution under the direct influence of the free market, aiming for maximum profits and ever increasing market shares, favours the fulfilment of the "wants" of the rich rather than the "needs" of the poor.

2.8 Restoring the Importance of Holistic Community Development: The "Family of 4" and the "Family of 4 PLUS"

The author's extensive experience working and living in the villages in this region of Nepal, in combination with the teaching and reading of the development literature, have convinced him that a return to a HCD model is the most likely approach to bring real and sustainable life changes with positive health improvements for local people. The author began implementing the current model of HCD in Humla with RIDS-Nepal and its donor partners in 2002, after baseline studies of the target communities, carried out in consultation with members of each household and in group discussions between the local people and the project team, identified a latrine, a stove, electric indoor lighting and clean drinking water as their most urgent needs to be addressed. This confirmed the author's previous experience of working and living for years in remote communities in Nepal (Zahnd 2003, 2004b, c). Hence, these most pressing needs, understood to be deeply interlinked with each other, have been defined as the "Family of 4", intrinsically intertwined and thus compelled to be applied and implemented concurrently (Zahnd and Haddix 2005). At the baseline, none of the households in these villages has indoor lighting, a smokeless stove for heating/cooking (householders still heat and cook with open-fires), a place for human waste disposal other than the fields surrounding the village, or clean drinking water. Thus, after the RIDS-Nepal team begins the first 2 years phase of a "Family of 4" HCD program partnership with the village, each household has access to the following "Family of 4" program's components (Fig. 2.10):

- A pit latrine.
- A smokeless metal stove with a hot water stainless steel tank.
- A basic indoor lighting system (solar PV/Pico-hydro/Wind Turbine, with three 1 W white LED lights per household).
- Access to clean drinking water from tap stands, from a community owned spring.

It is an essential part of the "Family of 4" program that each of the four "pillars" are continually developed, based on the ongoing learning of implemented projects and the resulting feedback of the end-user communities. Thus the various components of the "Family of 4" undergo ongoing improvements, based on monitored field research data and anecdotal end-user experience. While the

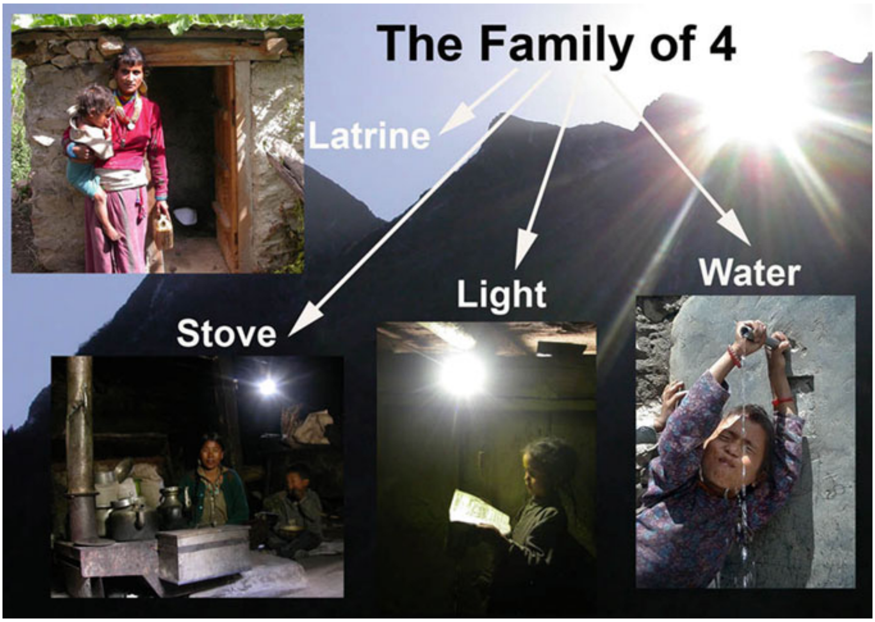

Fig. 2.10 The "Family of 4" consists of a pit latrine, a smokeless metal stove, basic indoor lighting for each household and access for families to clean drinking water from village tap stands

design of the pit latrine, the smokeless metal stove[5] and the gravity fed drinking water systems have already reached a high level of appropriate design and local manufacturing, the WLED lamps experience almost a yearly redesign due to the fast development of the relatively new WLED technology and thus consequent availability of improved diodes in the market.[6]

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[5] In 2006, the Nepal government announced a nation wide forthcoming, long-term subsidised stove program. Thus a 2 year evaluation of the major available stoves in Nepal was launched, which resulted in the approval of the author's designed and developed "Jumla design" smokeless metal stove (SMS) as the National Standard stove model. Thus, since 2009, a nation wide stove subsidy program (subsidising 50 % of the manufacturing cost) with annual production of 50,000 SMS, is running.

[6] Since the initial development of white light emitting diodes in the mid 1990s by Dr. S. Nakamura from Nichia in Japan, the light output of the diodes has constantly improved, from initially 14 lm/watt in the author's first WLED electrification project in Jumla in 1999, to 83 lm/watt in RIDS-Nepal's 2009/2010 village electrification system. With this value, the WLED technology has reached good quality CFL's luminescence. Leading researchers in this field, such as Prof. A. Zukauskus from the University of Vilnius in Lithuania, as well as literature (see references 5 and 6 in Appendix 15.13) show that till 2020 WLED lights will be on the market with a luminosity of 200 lm/watt. Thus this compels RIDS-Nepal to continue to invest effort into the constant redesigning and development of the WLED indoor lighting technology applied for the Humla communities.

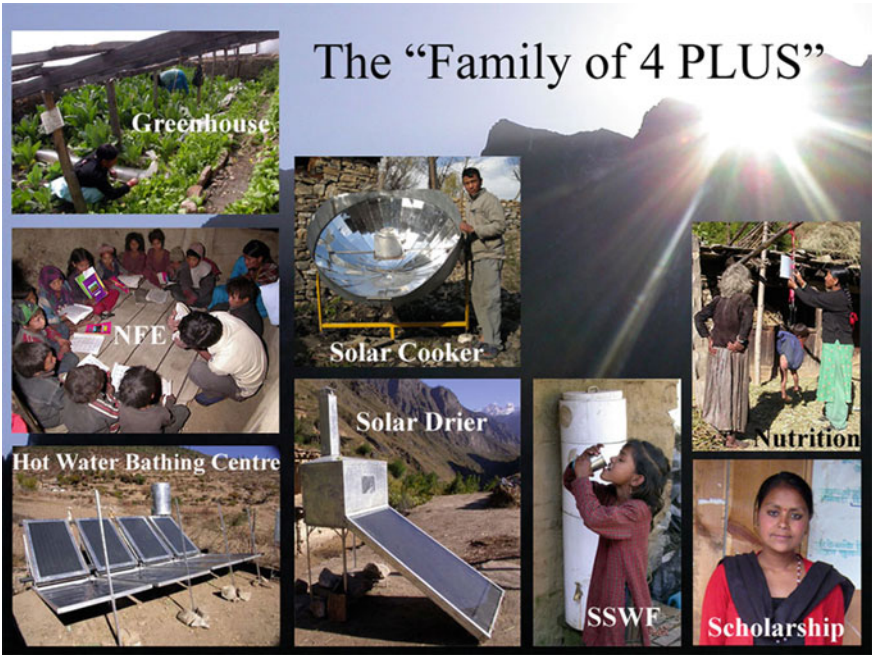

Fig. 2.11 The "Family of 4 PLUS" consists of greenhouse(s), solar drier(s), NFE (Non-Formal Education) for mothers and out-of-school children, a solar water heater bathing centre, an indoor slow sand water filter for each home, a mal-nutrition program for children <5 years of age, solar cooker(s) and a scholarships for apprenticeships for young Humla women/men

With the "Family of 4" being implemented for each family in a village, the people experience positive changes over time. They become increasingly aware of additional needs they would like to be addressed for their family's/community's long-term development. Thus, once the "Family of 4" program has been running for about 2 years, the second phase, the "Family of 4 PLUS" program (Fig. 2.11), again derived from anecdotal experience collected from the "Family of 4" program end-users and RIDS-Nepal's experience of working and living with the communities, can be launched. As the main basic needs have been addressed in the "Family of 4" program, the "Family of 4 PLUS" program includes a wider range of identified needs, which can change from village to village, according to their circumstances. Again, each project is part of ongoing development process through field research, data monitoring and the periodically conducted follow-up surveys in the villages. Thus, till 2012 eight components of the "Family of 4 PLUS" program have been defined, developed and, if identified by the local community, are implemented in partnership with the villages.

- Greenhouse for high-altitude villages.[7]
- Solar drier in the village.[8]
- Slow Sand Water Filter (SSWF).[9]
- High-Altitude Solar Water Heating (HASWH) bathing centre.[10]
- Access to a nutrition program for malnourished children <5 years of age.
- Non-Formal Education (NFE) classes for mothers and out-of-school children.[11]
- Solar Cooker for cooking during the day.[12]
- Karnali Technical School scholarship for a 2.5-year hands on apprenticeship.[13]

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[7] A PhD student from the University of Melbourne, AUS, with the author's co-supervision, is supporting the further development of the initial RIDS-Nepal high-altitude greenhouse concept and design.

[8] Since 2007 the Nepali government is providing a 50 % subsidy on the solar drier, developed by the author through Kathmandu University student research projects from 2002 to 2004.

[9] The SSWF, developed by the author, is since 2008 available on the local market.

[10] The HASWH is since 2006 available on the local market. It has been developed by the author through Kathmandu University student research projects from 2003 to 2005.

[11] RIDS-Nepal developed under the leadership and guidance of the author, till end of 2011 four NFE work books for the women and out of school students of the RIDS-Nepal NFE classes. The four work books (chapter Appendix 17) are also available for other local NGOs and interest groups in indigenous literacy programs from the RIDS-Nepal web site at: http://www.rids-nepal.org/index.php/Non-Formal_Education/View_category.html. Accessed 26 July 2012.

[12] Another alternative is the use of solar cookers (e.g. the parabolic SK14 solar cooker), utilising the Sun's power to cook, heat water for hygienic purpose, and to drink. However, good and proven this technology is, the promotion and use of a solar cooker poses particularly enormous obstacles to indigenise and make it widely used and appreciated in the local community. Issues such as the cooking hours, which are limited to sunny days and day hours, when the women are mostly engaged in field and crop work, or to have women cook outside the house, where they can be seen and where evil spirits have easy access to the food, are just some of the reasons why it is very hard to convince the local people that the solar cooker is a realistic alternative, alongside the smokeless metal stove. This, because the solar cooker demands significant changes and alterations to their prevailing culture and belief systems, which are deeply rooted in the local society and hard to change. However, RIDS-Nepal has in all its offices at least one SK14 solar cooker installed and in daily use, to demonstrate that it is possible to use a solar cooker in this environment and that we can save precious firewood resources. Local people are invited to come and share the experience and see for themselves that the food can be cooked with a solar cooker and that it tastes the same if not even better and is in no way "cursed" by any evil spirit. In these practical ways, living and working alongside local communities we hope to slowly penetrate the thick layer of culture through the practical examples of making the solar cooker an integrated part of our life and work.

[13] RIDS-Nepal's scholarship program provides a unique opportunity to young women and men from remote Humla villages for a Technical and Vocational Education and Training (TEVT) at the Karnali Technical School (KTS), in Jumla, a 7 day trek south of Humla. Till end of 2010, three young people from Humla villages have successfully completed their TEVT courses and are employed in different governmental and non-governmental development organizations in Humla. Since 2009, a further four Humla students (two women and two men) have enrolled in this scholarship program at KTS. The students, in consultation with RIDS-Nepal, can choose the

We believe in the synergistic effect of a project such as our "Family of 4" and "Family of 4 PLUS" because we have seen individuals and groups (e.g., women) rally together in ways they never did before, and take a qualitatively different and new approach to problems facing them. For instance, the NFE classes targeting women bring literacy to members of this community who have never previously been able to read posters or brochures with health messages. Two short examples illustrate the point. Now, not only can women read them, but this ability seems to reinforce their interest in building and maintaining their family latrine, and in the protection of the cleanliness of their water source. Emboldened by new knowledge and skills, we see women seeking out more information and innovation to improve other elements of their lives in a fashion that is hard to imagine if we had limited our scope to providing, say, latrines alone.

Thus, the "Family of 4" and "Family of 4 PLUS" HCD concepts enable villagers to pursue their efforts for the changes and development they eagerly want to see taking place in their families and villages. It is easy for people to appreciate the benefits to themselves, their families, and the larger group from participating in such a project.

2.9 Sociocultural Features of the Villages and Our Field Staff Team

In RIDS-Nepal we believe that people are the centre of each project, and applied technologies serve and support them toward improved living conditions. This approach demands that the local context, language and culture have to be learned and understood in order to comprehend the unspoken and invisible "software" issues of the community. This demands time, compassion and dedication—crucial parts of a project, difficult to identify and judge and even more difficult to budget and "sell" to some donor agencies.

To a very large degree, the success of the RIDS-Nepal projects in Humla is based upon the strengths and character of the team members on the ground. In addition to the author's background in applied renewable energy engineering, we have local team members who work full-time, year round on the projects and who come from Humla or the neighbouring district, Jumla. The Jumli team members have completed extensive hands on training as well as certificate programs in

(Footnote 13 continued)
profession they want to study. RIDS-Nepal is supporting this program through funds raised from philanthropic organisations and individuals. The TEVT Scholarship Program is important as it provides local young women and men with a unique opportunity to learn a trade (construction sub-overseer, agriculturist) or profession (nurse, midwife), which are urgently needed in such remote and impoverished areas as Humla. With this scholarship program, the required skilled workforce for Humla can be developed over the coming years, empowering local individuals with the right tools and education and thus they can increasingly take the responsibility of development of their own communities into their own hands.

sustainable technology at the Karnali Technical School, and each of them is matched by a Humli counterpart whom they personally trained. RIDS-Nepal also has close ties with the Kathmandu University (where the author is a lecturer and researcher since 2001) and other international Universities, with whom joint research projects are conducted every year. Our field staff contains both male and female employees who are well trained in the applied technologies, and are articulate, motivated, and of middle and lower castes.

Although Nepal has formally abandoned the caste system, features of the system still prevail in most parts of the country and dictate social discourse and patterns of interaction. In Humla, villages are usually mixed in terms of caste composition, ranging from the lowest (Dalit) to the second highest (Chettri) caste. Humlis tend to be humble people who can be ill at ease with high caste urban Nepalis. Our team is composed of approachable individuals, each of whom has a special mix of lower/middle caste position, good education, excellent linguistic skills and all are native to the rural areas of Western Nepal. In addition to the transparency of the project budgets and accounting and the quality of the work, we know that the social skills and capacities of our team make them highly effective on the ground. RIDS-Nepal was the only development organisation permitted to work in Upper-Humla undisturbed by the Maoists during the recent insurrection. This is remarkable, given that during the same period (2002–2007) many offices involved in community development throughout Nepal were shut down, project activities ceased and some offices burned or ransacked.

In the sections below some of the main project components, central to our long-term HCD model, as well as some of the "soft" features that distinguish our experience with them, are briefly described. Each of the pieces of equipment that we install is developed locally, bearing in mind the cultural, meteorological, social and economic contexts and the technical limitations of working in this valley. For example, we needed to balance such considerations as the materials available in the villages to build the latrines, accommodating the heating needs and culinary preferences of local people in the design of the smokeless metal stove, the architecture of the houses in the design of the stove pipe, the amount of solar irradiation available in every household/cluster of households in each village considered to be electrified with a solar PV system, and so forth.

This level of detailed research, development and customising of technologies is part of what we call "contextualised" technology. It demands significant fore-thought and long-term commitment to working in the villages, "tweaking" the technologies as new demand or behaviour patterns evolve, and resources to put into baseline needs assessment and follow-up research lasting for at least one generation ($\sim$10–15 years).

An example illustrating how important it is to contextualise technologies comes from our experience with stoves in Humla. While most of the local families cook and heat on open-fires, there are a variety of types of stoves to be seen around the valley. Some function only as benches or counter space, seeming to have been designed with profit (alone) in mind, as they do not come anywhere close to meeting the energy service demands of the people. What local people told us that they want is a cooking and heating system that allows them to prepare multiple dishes simultaneously, to produce the national dish of *dal bhat tarkari* (lentils, rice and vegetables) twice a day, hot all at the same time, whilst also warming the room in the winter. Humli people also like to eat a type of unleavened bread (*roti*) that has to be toasted against hot coals to produce the desired taste. These demands are tough to manage on a single burner stove or open-fire place without an air flow regulator or exhaust damper, in order to control the combustion process according to the meal being prepared or the heating demands of the season.

The RIDS-Nepal smokeless metal stove, designed by the author, in contrast, is designed to meet these preferences, with an easily adjustable air intake and exhaust pipe valve, three burners on which food can be simultaneously cooked, and a toaster slot to toast *roti* against the coals (Figs. 2.2, 2.5, 2.7, 2.14, 4.7, 4.10 and 4.11). All of these tasks can be accomplished without opening the front of the stove, which is critical, since operating a stove with the door open allows smoke into the room, and causes the combustion rate to flare out of control, increasing the rate at which firewood is consumed. Each of our stoves has a stainless steel water tank abutting one side, where water can be easily boiled and stored for drinking, washing, or other needs. Further, each stove has a unique number so that we can follow it up for years to come. This has proven important for quality monitoring and trouble shooting.

In Sect. 2.10 we describe, in detail, each of the HCD components in the "Family of 4" model and in Sect. 2.11 the "Family of 4 PLUS" components.

2.10 The "Family of 4"

The "Family of 4" is a set of innovations that are installed, as a group, into each home in a target village. It includes a pit latrine, a smokeless metal stove, basic indoor lighting (through a locally available and readily utilised renewable energy resource such as solar, hydro or wind), and access to a safe drinking water system.

Common and easily treated conditions prevail in the target communities, and make life in this already challenging biophysical environment utterly miserable for many villagers. Some of the primary conditions affecting people in the remote mountain communities where we work are: scabies and other skin conditions, due to unhygienic living conditions; chronic and often severe upper and lower respiratory chest infections, due primarily to indoor air pollution from cooking over open-fires; gastro-intestinal worms and other parasites due to the lack of human waste disposal systems; and dysentery and Giardia infections from polluted drinking water.

To address only one of these problems with a technical solution is often done by donors with a limited mandate, time frame, or budget. While such limitations are a reality for many donors, experience shows that a single-pronged approach is neither sustainable nor beneficial in the long-term. The lure of the single-pronged approach—its simplicity, the possibility of completing the project within a single fiscal year for results to be reported back to the donor, and so on—must be resisted.

The “Family of 4” HCD approach addresses the key features of village life which are responsible for primary health problems. The synergistic benefits of the components are consequently many times more powerful than individual projects, such as “just” lighting, or “just” clean water, or “just” better sanitary conditions when implemented alone.

2.10.1 Pit Latrine for a More Hygienic and Private Environment (1st in the “Family of 4”)

Usually, people in these villages defecate wherever a free and private place can be found. Due to lack of awareness of the importance of hygiene and sanitation, a shortage of land, and with no local examples to imitate, the pit latrine is not a traditional part of the infrastructure for a household. In the “Family of 4” model, the pit latrine is the first component to be built (Figs. 2.12 and 2.13). Work on the smokeless stove and the indoor lighting (solar PV/pico-hydro systems) does not proceed until the less exciting, lower prestige work of building the latrine has been finished. Because human waste is considered to be “polluting” in the local ideology, people hesitate to be associated with the building of a latrine or its maintenance.

We also know from other studies that women like to go in small groups to guard one another and to use the opportunity to socialise with their peers away from the scrutiny of their mothers in law (Dhakal, personal communication, 2008). Encouraging people to overcome this set of beliefs and associated habits has been one of the largest challenges we face.

An approach that we have found useful is to increase awareness and education about the issues surrounding hygiene and sanitation with posters/brochures/flip charts we designed as well as with songs written in the local dialect, using images familiar to people from their own valley (Appendices 20, 21, 23 and 24). We also emphasise these messages using the same materials (and more) in the NFE classes (Appendix 17). Gradually, people see the need to use and properly maintain their pit latrine. As a result, the walking paths, the surrounding village fields, and the streams are cleaner than ever before, greatly diminishing the risk of the spread of diarrhoea and other diseases.

2.10.2 Smokeless Metal Stove for High-Altitude (2nd in the “Family of 4”)

In terms of energy, Nepal’s traditional biomass fuel consumption provides for 85–90 % of all energy services nationwide and 100 % in remote mountain areas such as Humla. An open-fireplace with no chimney and a home full of smoke is “normal” in Humla. Often, the daily firewood consumption is 20–40 kg (Zahnd

Fig. 2.12 The first “pillar” of the “Family of 4” is always the Pit Latrine (PL), one per family, as preventative health care through improved hygienic conditions and environment is a crucial pre-requisite for sustainable development

Fig. 2.13 Children are the main ones to be taught how to use the PL daily, as they are the ones who get used in the most natural way, and thus it becomes part of their new culture

1998, unpublished data), and the indoor air pollution has a direct damaging impact on the health of women and children in particular (ITDG n.d.). This causes respiratory diseases, asthma, blindness and heart disease (IEA 2002), resulting in the extremely low life-expectancy for women and the high death rate of children <5 years of age in Nepal (Warwick 2004; IEA 2002). Increasing deforestation results in a scarcity of local firewood, forcing women and children to spend 7–8 hours gathering fuel wood further afield every second day (IEA 2002; Haddix and Zahnd 2005).

Now, each household has an efficient smokeless (i.e. with a chimney flue) metal stove, with a firewood consumption rate of nearly half previous levels (Fig. 2.14). As described above, the stove is designed for local culinary preferences and heating needs. The stove is also time efficient, as it allows women to cook *dal bhat*

Fig. 2.14 The Smokeless Metal Stove (SMS), designed by the author in 1998. Up to 2011 an estimated 25,000 homes (through RIDS-Nepal, the government subsidy program and other NGOs) in the remote districts of Nepal have had this SMS now installed. It cooks the traditional food all at one time, uses ~40 % less firewood, provides appropriate room heating and 9 liters of hot water for drinking the local "butter tea" as well as facilitating an improvement in personal hygiene. This is called "contextualised" technology, with people, their culture and way of living in the centre and technology developed to suit them in their context

tarkari all at one time, and it provides hot water for drinking and washing in an attached 9 liters stainless steel water tank. The stove ensures a smoke free, cleaner, and safer home environment, where children are no longer at risk of falling into the open-fire. Thus, it comes as no surprise that women, the main users and organisers of the family's energy demands, esteem the SMS.

2.10.3 Solar PV System (3rd in the "Family of 4")

The conceptual basis of HCD projects is that various needs, as identified by the target population, cannot be addressed simply using a single approach. Rather, primary health and resource dependent needs have to be addressed in a comprehensive, multi-pronged approach. Villagers articulate their primary needs and help to design projects that efficiently, sustainable and holistically address them. Thus, electricity is "just" one of the four pillars of the "Family of 4" concept.

However, by only attending to one piece of the overall picture, other critical needs can be neglected, such as a lack of a human waste removal system, and contaminated drinking water. In such an eventuality, the installation of lights will be of marginal benefit and the potential health benefits resulting from the new lighting system could not be clearly demonstrated.

In order to understand the local population's need for indoor lighting, it is important to understand how homes were lit previously and what activities occurred in homes after dark. In Humla, all families traditionally use *jharro*—a resin rich wooden stick from high-altitude pine trees (Fig. 2.15)—to light indoor living spaces. Burning *jharro* provides very smoky and minimal indoor lighting (Fig. 2.16).

Traditionally, every person in the Humla villages uses the open-fireplace for lighting their home interiors, in addition to cooking and heating. In this culture, women and children are most likely to suffer from the heavy load of indoor smoke pollution (Warwick and Doig 2004), causing respiratory diseases, asthma, blindness and heart disease (IEA 2002). While the US-EPA (Environment Protection Agency) PM_{10} 24 h standard is set at 150 μg/m^3, not to be exceeded more than once per year on average over 3 years, indoor open-fire places create PM_{10} levels ≥20,000 μg/m^3 (Warwick 2004, RIDS-Nepal unpublished data) on a daily basis, for hours at a time.

Thus, once the potential health improvements, the improved social gatherings and the better educational opportunities for their children through basic indoor lighting are understood, it is clear that it is frequently on the top of people's lists of the needs to be addressed.

In order to design a solar PV village system that will reliably light a house over its life span, the following issues were important for our team to identify and monitor:

- The solar irradiation (kWh/m^2/day) for the location of the solar PV system.
- The village's population, annual growth, its load distribution and growth pattern.
- The sustainability, ease of installation, and maintenance of components.
- Feasibility and reliability of locally developed and manufactured products.
- Trade off between sustainability/cost versus high efficiency.
- Participation of all stakeholders in every project step, including in economic terms.
- Culturally appropriate training, hand over, operation and maintenance.
- Minimal or no ecological impact during installation and operation.

In Sect. 3.3.2, the three types of solar PV systems (single home, cluster, and centralised village systems), which the author developed and installed in Humla through RIDS-Nepal, are described in detail, (Zahnd and Haddix 2007a). Here, a cluster system is briefly described. Using the checklist described above, 18 clusters of 4–12 households were defined in RIDS-Nepal's project partnering village Dhadhaphaya.

Each cluster has a central house, chosen by the community, on whose rooftop a 75 W_p PV module is mounted on a seasonally adjustable aluminium frame (Fig. 2.18). In that house, usually in the kitchen, is a 12 V DC battery-bank, consisting of 2 deep-cycle, 12 V DC solar batteries, each with 100 Ah capacity. They are in a locally made wooden box, insulated with the initial packing material

Fig. 2.15 "*jharro*" production from high-altitude pine trees kills the trees slowly

Fig. 2.16 "*jharro*" the traditional means to generate light in the home, or while walking in the village in the night. Strong black smoke, soot and a very dim light is the output

(Figs. 2.17, 3.35, 3.43, 3.91, 3.92 and 3.104) and with locally available silver birch tree bark and pine needles.

Each household gets three 1 W WLED lights, connected to the cluster battery-bank through armoured underground cables. These 1 W lights, with 83 lm/watt[14] have a life-expectancy of up to 100,000 hours (Craine 2004). The lamps are developed and manufactured in Nepal by Pico Power Nepal.[15] They provide

[14] Each WLED lamp consists of 12 high quality Nichia NSWP510DS WLED diodes with a 50° light angle.

[15] Pico Power Nepal (PPN) can be contacted through Mr. Muni Raja Upadhaya, at: muniraj@rids-nepal.org or through the author.

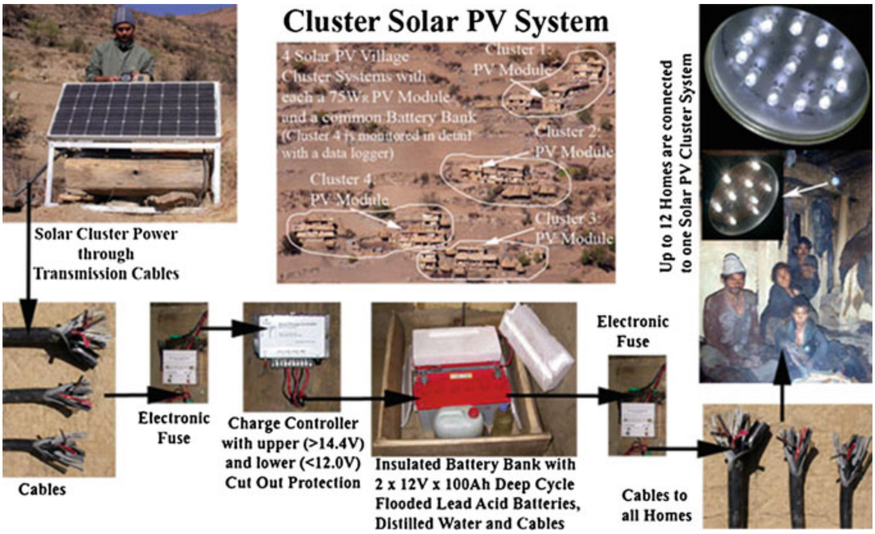

Fig. 2.17 Cluster Solar PV System Schemata as installed for four clusters in Pamlatum village in Humla through a RIDS-Nepal's long-term HCD project

Fig. 2.18 A solar PV cluster system for up to 12 homes. One 75 W_p PV module (*right side*) generates power which is stored in the battery-bank installed inside the home. All other cluster homes are connected through underground cables to the battery-bank, which provides up to 3 days of power without sunshine

enough light to socialise, read, and carry out other daily tasks, thus eliminating the need for an open-fire or *jharro* for lighting.

Some of the "soft" factors associated with a project like this are monitored by our team and compared with data collected in our baseline and follow-up studies, in which we ask members of every household about social and attitudinal expectations and changes associated with each project component. For instance, we carefully choose the household in which the battery-bank for each cluster system is located. This needs to be the household of an individual who is well respected, honest, and sociable.

We do not advocate cross caste user systems—each cluster of households drawing power from the same battery system should be comprised of families from

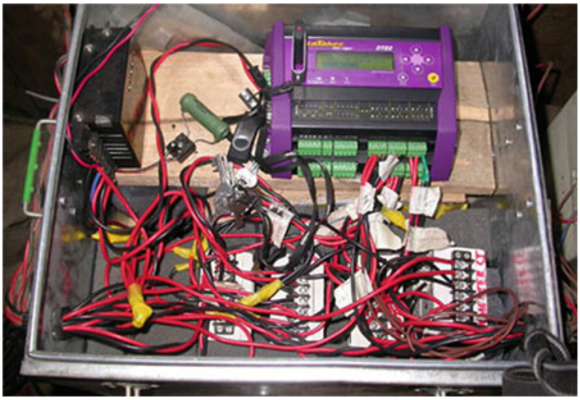

Fig. 2.19 A sophisticated dataTaker DT80 data logger monitors and records 22 different parameters for one of each of the three types of solar PV village systems the author developed. This provides us with detailed data for long-term performance

the same caste. This cuts down on conflict and disputes over usage load and maintenance duties.

Sophisticated data monitoring and recording systems installed in several typical PV system types in the villages (Fig. 2.19), monitor the daily solar radiation, the energy generated and stored and the consumers' usage and load over the course of the day, week, month and year. Using the data generated by these systems, we can see what the usage pattern looks like, how the people learn for the first time to live with electrical light inside their home and whether villagers are connecting other electricity using devices (other than the lights) into the wires. Further, they provide important data to understand the long-term performance of a PV system under real conditions. These data are crucial for the ongoing development of our projects, and help us make improvements to the solar PV systems. Our team is in and out of the households year-round, troubleshooting and training/re-training and helping address issues that arise until all the glitches have been removed.

2.10.4 Clean Drinking Water from a Community Owned Spring (4th in the "Family of 4")

The main rivers in Humla, contaminated by upstream villages, human waste, washing and disposal of dead animals, used to be the daily drinking water supply for most of the villages where we work. Now, in our project villages, water flows from tap stands that deliver clean water from the community owned springs high on the slopes above the villages. From the springs, water is brought through gravity flow to the villages through 50–90 cm deep buried underground polyethylene pipes to cemented tap stands, providing clean and fresh drinking water to clusters of households via local water tap stands in each village (Figs. 2.20 and 2.21).

This is often a very technically challenging project component, since the terrain is steep, rocky, covered with snow during the winters and dangerous in the areas

Fig. 2.20 Clean and pure water from the water tap for the whole family

Fig. 2.21 The water is brought via underground buried polyethylene pipes from the springs high above via gravity flow down to the village. In the village several water tap stands, defined by the local community, provide clean and fresh water 24/7, preventing unnecessary diseases

where the springs originate. Additionally, there can be some social tension associated with the spring and the location of the tap stands, and the users of each one. Members of higher castes prefer not to draw water from the same tap as members of the lowest castes. They make these preferences known to our team members in a way that, given some of our team members' own lower caste positions, can be hurtful and discouraging.

This is a feature of a caste bound society like Nepal's that can factor into projects in ways that can be damaging to team spirit and the ability of groups of people to work together. Despite the experience of frequent frustrations such as these, we have been able to successfully navigate these difficult issues to date with commitment and diplomacy—mainly because we are aware of the issues and invest the time and effort to confront and address them.

Fig. 2.22 The High-Altitude Research Station (HARS) which is also the RIDS-Nepal Simikot field office. Here the newly developed RETs, often emerging out of collaborative projects between RIDS-Nepal and universities around the world, are field tested. Problems can be identified and technologies improved, before they are considered ready to be implemented in the project villages. This is important for developing contextualised technologies and long-term sustainable HCD

2.11 The "Family of 4 PLUS"

2.11.1 Greenhousing and Solar Driers

With 199 days of frost in a year (NASA 2003; Zahnd 2004a), only 3–4 months (DDC Humla 2003) of agricultural work is possible. Thus many Humlis suffer permanent food shortages with high levels of malnutrition, especially in children. A low cost greenhouse prototype, constructed using local stones, wooden beams and UV stabilised plastic from Kathmandu, was built at the RIDS-Nepal High-Altitude Research Station (HARS) in Simikot, Humla in 2005 (Fig. 2.22). The greenhouse now produces vegetables for 10 months per year. This is absolutely critical as our data show that an astonishing 67 % of Upper-Humli children under the age of 5 have stunted growth, a sign of serious long-term malnutrition (Haddix and Zahnd 2005).

Further, in order to store the greenhouse's product yields in clean and hygienic ways, a solar drier was developed in tandem with Kathmandu University, as part of another practical student research project, led and guided by the author. These driers are now becoming popular in Humla, and allow families to efficiently and properly dry and preserve their precious foods for consumption in times of food shortage.

2.11.2 Non-Formal Education Classes for Mothers and Out-of-School Children

With a literacy rate for women as low as 4.8 % in Humla (KIRDRC 2002), booklets and brochures purchased in the distant cities are not appropriate for awareness raising and education, at least not initially. Thus we developed a novel, Humla specific NFE program for mothers and out-of-school children, with topics

Fig. 2.23 Women enrolled in the NFE evening classes meet 6 times a week to learn how to read, write and communicate. Teaching material is developed locally and the main themes are the "Family of 4"/ "Family of 4 PLUS" village project components

that support the "Family of 4" and "Family of 4 PLUS" projects, including pit latrine usage, cooking stoves, solar lighting, safe drinking water, greenhouses, solar driers, nutrition and improved hygiene (Appendix 17). These themes are taught in evening classes, initially through our pictorially based posters, games and songs (Appendices 19, 20, 22 and 23). As students' literacy increases, other locally relevant reading materials are introduced and used under the guidance of the RIDS-Nepal trained NFE facilitator (Fig. 2.23). In this way, the participants are immediately involved with subjects relating to the other project components which have been or are being implemented in their village, at a level appropriate to their educational experience, leading them to discover the benefits of functional literacy, and ultimately to participate in the development of their own teaching materials.

2.11.3 Nutrition for Malnourished Children <5 years of age

As indicated above, a very high number (67 %) of children <5 years old are malnourished in our project villages. This reality is the result of unproductive land, the harsh environment, unpredictable, recurring natural calamities like landslides and droughts, remoteness and lack of knowledge of how to utilise the minimal available foods for maximum nutritional benefit. To begin to help this situation, we developed a nutrition program for the most malnourished children <5 years of age and their mothers, in the project villages. Up to 10 mothers per village are instructed in basic nutrition, and trained how to mix and prepare a super porridge called "*sarbotham pitho*". This is made from locally grown lentils, wheat, soya beans and corn. This is added to the diet of the most severely malnourished children in the village. Weekly, the mothers of these children are visited by one of our female team members, for counselling and to answer questions and help with problems (Fig. 2.25). On a monthly basis, each child is weighed and measured (Fig. 2.24), and data are recorded so that each child's growth and health condition can be tracked.

Fig. 2.24 Malnourished children identified by the village and <5 years of age are enrolled in the RIDS-Nepal mal-nourished children's program. Each child is weighed and its data recorded monthly

Fig. 2.25 Mothers, enrolled with their children in the malnourished RIDS-Nepal program, are counselled on a weekly basis. They are taught how to care and cook for the children. Everyday problems are raised and discussed

2.11.4 Solar Heated Bathing Centre

The rivers in this high elevation area have been found to be warmest from June to August, measured as 12–16 °C. The rest of the year they are between 4 and 12 °C. Thus, water for bathing needs to be heated by wood fires, and wood collection is already a huge burden for women. Thus, a commonly owned high-altitude solar heated bathing centre for women and men has been designed and built (Zahnd and Malla 2006).

The solar water heaters are based on the thermosiphon principle, and are designed and manufactured in Nepal, with hot water storage tanks and insulation to protect the system from freezing in the winter. These heaters were developed through a collaborative research project with the author's students at Kathmandu University. One bathing centre unit, consisting of four flat plate solar absorbers and

Fig. 2.26 The first (world wide) high-altitude bathing centre for a village community in Darapori village in Humla, Nepal at 2400 m altitude above sea level, developed as a joint Kathmandu University student research project with RIDS-Nepal, was commissioned in May 2009

one hot water storage tank, allows up to 300 people to enjoy hot showers (calculated at 10 l, 50 °C water per person) once every 2 weeks, addressing the pressing need to improve local hygiene. The population of a village defines the number of units needed. A "village bathing centre committee" is responsible for keeping track of and maintaining the infrastructure. A data monitoring system, recording the incoming solar irradiation, the intake water, the absorber, the hot water storage tank temperatures and the daily hot water consumption, was installed in the Darapori village bathing centre in May 2009 (Sect. 4.4.1.7, Figs. 4.66, 4.67, 4.68, 4.69, 4.70, 4.71, 4.72, 4.73, 4.74, 4.75 and 4.76), as well as in the first prototype high-altitude bathing centre in Simikot in October 2005 (Appendix 26.6, Figs. HASW_11–77). It provides valuable feedback for evaluation and future improvements (Fig. 2.26).

2.11.5 Slow Sand Water Filter (SSWF)

Although the villages with running "Family of 4" projects have a village based clean drinking water system, it is often the case that the drinking water gets contaminated by the way people store and handle the water in their homes.

Unhygienic conditions inside the home, attract flies, rats and other animals such as chickens and dogs, and pose a potential danger of pollution to the drinking water. Thus, the author developed an indoor Slow Sand Water Filter (SSWF) for the average household family size in the Humla district of six people (Figs. 2.27, 2.28 and 2.29).

The SSWF is filled with two kinds of sand, in order to first filter out the rough, more visual parts, before the actual biological process through the

Fig. 2.27 Teaching how to install and how to use the indoor SSWF by a RIDS-Nepal staff member

Fig. 2.28 Filling up the SSWF by a home owner for his restaurant

Fig. 2.29 Each family member benefits from the pure drinking water

"Schmutzdecke"[16] takes place in the main part of the SSWF. A 9 litre water tank, containing the purified water, is accessed by a brass tap. RIDS-Nepal's ongoing faecal e-coliform tests have confirmed that up to 98 % pure water can be achieved and maintained for consumption with the SSWF, which meets the Nepali standard.

2.11.6 Solar Cooker

With firewood being the only fuel resource to provide the family's basic cooking and heating services, it comes as no surprise, that deforestation in Nepal is wide spread (Figs. 4.4 and 4.5), causing annually landslides and the loss of land and lives. The RIDS-Nepal smokeless metal stove will slow down this devastating deforestation in the years ahead. However, it will take decades of measurements and limitations to firewood collection, with rigorous monitoring of the proper use of the stoves, to mitigate the severe destruction of Nepal's unique forests.

[16] "Schmutzdecke" is the German word for the fine layer of bacteria, which is responsible to "purify" the water running through the SSWF. This layer of bacteria is developed on top of the fine sand layer over the course of the first 10–14 days of use (filling the SSWF with water twice a day and emptying the filtered water). Because the "Schmutzdecke" consists of bacteria, the SSWF has to be filled daily so that the bacteria remain in a moist environment, as otherwise they would die and the filtration of the water would not take place.

An alternative, alongside the SMS, is the use of solar cookers (Appendix 26.5) to cook, heat water for hygienic purposes and for drinks. However, good and proven this technology is, the promotion and use of solar cookers poses particularly enormous obstacles to indigenisation in the local community. Issues such as the cooking hours, which are limited to sunny days and day hours, when the women are mostly engaged in field and crop work, or to have women cook outside the house, where they can be seen and where evil spirits have easy access to the food, are just some of the reasons why it is very hard to convince the local people that the solar cooker is a realistic alternative, to the smokeless metal stove. This is because the solar cooker demands significant changes and alterations to their prevailing culture and belief systems, which are deeply rooted in the local society and hard to change.

2.11.7 Karnali Technical School

RIDS-Nepal’s scholarship program provides a unique opportunity to young women and men from remote Humla villages for a Technical and Vocational Education and Training (TEVT) at the Karnali Technical School (KTS), in Jumla, a 7-day trek south of Humla. So far, three young people from Humla villages have successfully completed their TEVT courses and are employed in different governmental and non-governmental development organisations in Humla. Since 2009, a further four Humla students (two women and two men) have enrolled in this scholarship program at KTS. In consultation with RIDS-Nepal, the students choose the profession they want to study.

RIDS-Nepal is supporting this program through funds raised from philanthropic organisations and individuals. The TEVT Scholarship Program is important as it provides local young women and men with a unique opportunity to learn a trade (construction sub-overseer, agriculturist) or profession (nurse, midwife), which are urgently needed in such remote and impoverished areas as Humla. With this scholarship program, the required skilled workforce for Humla can be developed over the coming years, empowering local individuals with the right tools and education to increasingly take the responsibility of development of their own communities into their own hands.

2.12 Expected Results

If the hypothesis is correct, that a holistic project, in close partnership with the community, will have a more sustainable long-term impact than individual projects, planned periodical impact surveys should identify this. Beyond the quantitative changes currently (Haddix and Zahnd 2005) being monitored in villagers’ time usage, morbidity, and nutritional status, a range of qualitative impacts are being monitored, including:

- Overall improvement in hygienic conditions inside and around the homes.
- Decrease in firewood consumption for cooking, heating and lighting purposes.
- Increase in women's literacy rate, with more girls joining the local school.
- Increase in social interaction, now possible in community gatherings after dark.
- Increased community based, community initiated development projects.
- Less breakdown times, improved use and maintenance of the new technologies.

The experience of working in the front line of holistic community development shows, that the MDGs will be hard or impossible to achieve in the set time frame. This is partly because they were defined primarily by professionals who had limited or no exposure to, or lived among the people experiencing the realities the MDGs were designed to change.

The anthropological insight and practical experience gained over the last decades makes clear that the lack of dignified human living conditions for individuals, communities, even whole districts or regions cannot be addressed with one off, single-pronged, approaches within a fiscal year. The author argues that development efforts must be designed from the bottom-up, from the grass-roots level, according to the end-users' perceptions of their most urgent needs, rather than according to a donor's development agenda.

This is not an entirely new concept, and, for the field of international development in the health sector, was well developed and quite adequately articulated at Alma Ata in 1978. Developments in foreign aid around the globe since then have dramatically shifted project design away from comprehensive and grass-roots approaches towards selective, single-pronged projects designed from the top-down, which it is argued have undermined the efforts themselves as well as people's faith in the overall endeavour. But people's concerns, needs and problems are never simple, nor simply solved. All human needs are couched in complexly nuanced physical, social, mental and spiritual environments. Issues to address in development projects must always be understood, discussed collaboratively and analysed in the specific context of the ultimate beneficiaries. By definition this means that project planning should always unfold collaboratively with the target community and that the planning process should fit as comfortably as possible within local traditions, beliefs, and behaviour patterns, as well as the geographical and climatic context. Thus, unless a paradigm shift toward retooling development efforts in the direction of small scale, bottom-up, grass-roots based, holistic community development takes place, the author believes that there is little hope of reaching the noble but heretofore unobtainable MDGs.

In addition to the value placed on the holistic approach to community development projects targeting health outcomes, the author has learned to pay due respect and importance to relevant, cultural milieu. Project planners and implementers must spend time living in the target community. The amount of time shared living with local end-users or beneficiaries of the development effort does not necessarily have to be protracted. But it is critical for project planners and implementers to have a solid sense of local behaviour patterns, social hierarchies, expectations of the development effort and barriers to success.

Hard experience has taught us that there is no short cut to sustainable and appropriate development. Living with the people targeted by the project, and learning to understand and respect the logic behind local culture and ancient tradition is crucial to the relevance of any HCD project.

In an earlier latrine installation effort, we were initially flummoxed by the fact that despite the appearance of abundant open space in which to place the latrines, no villager seemed to believe their household could afford the space for a latrine. The logic to their protestations slowly emerged—that piece of land was inhabited by a spirit that could not be polluted; another was the subject of a three generation old dispute over ownership; a third was too close to rice, a sacred crop, not to be contaminated by proximity to human waste (Zahnd and Haddix 2007b). These nuances cannot be learned from books nor downloaded from the Internet—and without patience and a deep respect for local people and their perceptions of reality, issues such as these can develop into complete impasses, or can lead to projects that quickly unravel after the implementers depart for the capital city. Real life experience has to be the basis for context relevant, respectful and dignified sustainable development.

Our experience in the field compels us to argue that only a long-term HCD approach can sustainable and responsibly bring about serious change in terms of health outcomes and livelihood improvement for people living in remote impoverished conditions such as in Humla. We would like to see a wide scale paradigm shift, back to long-term, holistic, multi-pronged projects that are reliant upon villager led needs assessment and rigorous, annual, household level studies of the social, attitudinal, technical and health outcomes associated with the studies.

Ideally, projects should have long-term donor commitment for the follow-up and maintenance of projects. Projects need not be large scale, as in the case of the exemplary Millennium Village Project[17], which shows already encouraging results if the vision of holism becomes reality as reported by the Economist for several villages in Western Kenya (The Economist 2006). The commitment needs to be long-term, because the positive effects to be experienced as a result of this kind of effort will not be tangible in the short-term. Donors and project staff members also need to be aware of the fact that by and large this type of work is not generally profit

[17] The Millennium Project was commissioned by the United Nations Secretary General in 2002 to develop a concrete action plan for the world to achieve the Millennium Development Goals and to reverse the grinding poverty, hunger and disease affecting billions of people. The Millennium Villages are based on a single powerful idea—impoverished villages can transform themselves and meet the Millennium Development Goals if they are empowered with proven, powerful, practical technologies. By investing in health, food production, education, access to clean water, and essential infrastructure, these community led interventions will enable impoverished villages to escape extreme poverty, something that currently affects over 1 billion people worldwide. http://www.unmillenniumproject.org/mv/index.htm. Accessed 26 July 2012.

making in the short-term. At some point, small shops and businesses may, and should, indigenously emerge to service the long-term equipment needs to maintain and improve different project components. This can represent an important development for local people to help them to engage, if they wish, with the cash economy.

Finally, it is important to remind the reader that change in behaviour may be slow, and may take up to two generations to occur. This is especially true for project components such as latrines, which are so heavily laden with symbolic meaning that may, at first, be invisible to newcomers to the cultural and social system. Working with local people with patience, compassion, and a shared understanding of the commitment each side has made to tackle the challenges that will inevitably arise, is necessary and will bear fruit that will nourish all participants, in the longer term.

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