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A RIGHTS-BASED APPROACH TO INDOOR AIR POLLUTION

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ABSTRACT

Household indoor air pollution from open-fire cookstoves remains a public health and environmental hazard which impacts negatively on people's right to health. Technologically improved cookstoves designed to reduce air pollution have demonstrated their efficacy in laboratory studies. Despite the tremendous need for such stoves, in the field they have often failed to be effective, with low rates of long-term adoption by users, mainly due to poor maintenance of the stoves. In poor, rural, isolated communities, there is unlikely to be a single behavioral or technological "fix" to this problem. In this paper, we suggest that improved cookstoves are an important health intervention to which people have a right, as they do to family planning, vaccination, and essential primary care medicines. Like these other necessary elements in the fulfillment of the right to health, access to clean indoor air should be incorporated into state health strategies, policies, and plans. State infrastructure and health systems should support public and private sector delivery of improved cookstove services, and ensure that such services reach all communities, even those that are poor, located remotely, and likely not to be served by the market. We suggest that community health workers could play a critical role in creating demand for, implementing facilitation and delivery of, and monitoring these cookstoves and related services. Through this approach, improved cookstoves could become an appealing, available, and sustainable option for the rural poor. In this paper, we adopt a human rights-based approach to overcome the problem of indoor air pollution, and we use Nepal as an example.

INDOOR AIR POLLUTION: A GLOBAL HEALTH AND JUSTICE PROBLEM

An estimated three billion people across the globe depend on rudimentary, open-fire cookstoves to cook food, boil water, and heat homes.[1] Wood, coal, animal dung, and other biomass fuels are used by up to 90% of rural households in sub-Saharan Africa and Asia.[2] Globally, cookstoves represent roughly 15% of overall energy use.[3] Yet this simple use of traditional cookstoves has been shown to account for significant health, environmental, and economic consequences—repercussions that disproportionately affect the women and girls typically found working with and around cookstoves.

It is estimated that indoor air pollution (and the inhaling of acrid smoke and particulates released by the burning of traditional biomass fuels) is the direct cause of millions of deaths each year, 99% of which occur in developing countries.[4] Exposure to smoke from cooking is thus ranked as the fifth worst risk factor for disease in these areas.[5] Indoor cooking smoke emits quantities of particulates up to 20 times higher than the maximum recommended levels by the World Health Organization (WHO), linking it to conditions including, but not limited to, acute respiratory infections, lung cancer, chronic obstructive pulmonary disease, heart disease, blindness, and low birth-weight.[6] Furthermore, nearly half of all pneumonia deaths among children under five occur as a result of

smoke exposure, with pneumonia being the overall leading cause of death among children of this age group.[7] In addition to the harmful effects of smoke, open flames from cookstoves are a contributory cause of the over 200,000 burns that result in death each year.[8] Overall, the annual number of lives lost that were attributable to cookstove-induced ailments was approximately four million in 2010, roughly twice the number claimed by HIV/AIDS and quadruple those caused by malaria in that same year.[9]

Environmentally damaging effects are also significant. The sum of biomass cooking fuels used by a single family can reach up to two tons per year, totaling about 730 million tons in developing countries alone. The exhaust from burning this amount of biomass fuel releases more than one billion tons of carbon dioxide into the atmosphere each year.[10] In addition, biomass fuels emit significant levels of other greenhouse gases such as methane and nitrous oxide, and an estimated quarter of the global inventory of black carbon emissions, all of which have been shown to contribute to global warming.[11] Furthermore, with forest representing so much value as fuel, competition over forested land between local communities can be a source of conflict.[12]

A significant amount of time must be invested in collecting biomass. Women and girls in India spend up to 20 hours each week outside collecting fuel.[13] Other studies in sub-Saharan Africa saw that number reach up to four hours each day.[14] Not only does this use up valuable time that could otherwise be spent on education or income-generating activities, but it also puts the collectors—since they are almost always women—at a high risk of gender-based violence.[15] This is especially true for the women who are among the vulnerable 80 million people worldwide who live in conflict areas, where they are given food by United Nations agencies and relief organizations, but still must find fuel with which to cook. In general, families that purchase instead of collect fuel may pay up to a third of their daily income to cook a day's meals.[16]

There are clear benefits to reducing indoor air pollution. It must, however, be done in an affordable manner that allows households to continue to cook, heat, and accomplish other necessary activities traditionally carried out by stoves. The global response has thus been the production of technologically advanced cookstoves that require less fuel and produce less pollution, also referred to as improved cookstoves (ICS). Models have been created that, if used in place of traditional cookstoves, could significantly reduce health, environmental, and economic harm, while saving money through reduced fuel expenditures.

However, while efforts to implement ICS have been on the global agenda now for decades, few programs have seen absolute success. The consistency of ICS program failures, particularly in rural settings and among the socially marginalized, has indicated the need for a new approach to address this epidemic of indoor air pollution.[17] Because of the nature of these failures, described in more detail below, this new framework is one that must identify clean air as a key aspect of health and an essential human right. This does not obviate the need for market-based, behavioral-change models, locally appropriate technologies, or innovative maintenance strategies; rather, it acknowledges the role of state and local governments in providing a legal, economic, and governance environment that facilitates the realization of the right to clean air.

IMPROVED COOKSTOVES: GREAT POTENTIAL, THUS FAR SHORT-LIVED

Technologically advanced cookstoves exist that have the potential to save millions of lives, reduce harmful effects on the environment, empower women, and create economic opportunities for the poor. The range of ICS models is vast; some involve technologies that use cleaner burning fuels such as liquefied petroleum gas (LPG), biogas, ethanol, and solar power, while some are designed using more heat-insulating material or better ventilation mechanisms. Simple models with greater resemblance to traditional cookstoves have also been developed; these require lower investment costs and fewer changes in cooking techniques. All enhance fuel efficiency with the common goal of reducing indoor air pollution.

One of the better-known studies on ICS implementation, the Guatemala-based *Randomized Exposure Study of Pollution Indoors and Respiratory Effects (RESPIRE),* found that ICS-induced smoke reduction significantly decreased the number of cases of severe pneumonia among treatment households.[18] Though the RESPIRE study remains one of the only randomized controlled trials conducted on ICS effects on health, considering the multitude of diseases directly attributed to indoor air pollution, experts are confident

about the health benefits that ICS adoption could have for their users.

ICS can also reduce environmental harm. First, they can lessen the large amount of deforestation that occurs to support wood supply and charcoal production, a $10 billion dollar industry in sub-Saharan Africa alone.[19] Deforestation leads to mudslides, loss of watershed, desertification, and loss of biodiversity. Deforestation also places pressure on regional food security and agricultural productivity. [20] All of these negative outcomes could be lessened if demand went down as a result of ICS adoption. Second, ICS can cut emissions of greenhouse gases and particulate matter. A review of studies on black carbon control options in Asia found that household stove and fuel interventions achieved a relatively high reduction in black carbon emissions per unit cost.[21] Some estimate that ICS use has the potential to save up to one billion tons of carbon dioxide emissions over a time period of 10 years.[22] Others believe that, because most gases and particles released by cookstoves have short life spans, reductions in these emissions could leverage climate responses immediately.[23]

Finally, usage of clean and more efficient cookstoves can increase household savings. One metric used is the money saved from the reduced need for purchased fuels, while another is the time no longer needed to collect fuel, expressed monetarily by multiplying the time saved by average hourly wages. For a typical rural South Asian household, the benefits of switching from traditional biomass fuel to LPG cookstoves amounted to about US$30 per year.[24] For most of these families that earn on average less than $2 a day, the savings are significant.

Unfortunately, all of this potential has hardly been realized. Though the actual production and design of effective ICS have been tested successfully in laboratory settings, of the few studies that have examined actual behavior around these cookstoves, most have found low rates of adoption. One recent study conducted over a four-year time period in Orissa, a rural and impoverished region of India, failed to provide any evidence of better lung functioning or even decreased fuel consumption among households and users to which ICS were disseminated. The study found that households used the new cookstoves irregularly and did not make the required investments to maintain them. Usage rates in treatment households dropped from 3.5 more meals cooked on ICS per week than control households in the first year down to 1.8 more meals per week in the third year, illustrating the short life of this technology in real-world, rural settings.[25] It is important to note that the stoves in the research design were offered to users nearly free of cost, adding an as-yet-untested element of how the process of introducing ICS technologies may impact their ultimate durability.

Furthermore, though the RESPIRE study in Guatemala found potential for positive ICS-induced health outcomes, their program involved weekly home visits by fieldworkers who assessed stove functioning and arranged repairs as needed—support in maintenance not provided in the study in Orissa or in many of the places where ICS programs are implemented. In addition, the RESPIRE study monitored households for a relatively short time period of up to 18 months, while the study households in Orissa were tracked for up to four years.[26]

Findings such as these illustrate the need to create a lasting demand for, and supply of, ICS services. We now turn to why a rights-based approach may help to compel this sustained demand, increase government investment in clean air, and consequently, improve the durability of ICS interventions.

A RIGHTS-BASED APPROACH TO CLEAN INDOOR AIR

The Constitution of the WHO states that "the enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being."[27] In the past 20 years, this perspective on access to health care as a public good, guaranteed as an essential right of every person, has gained traction in the field of global health.[28] The stance is fundamentally a moral one, rooted in the belief that the only way to lessen the burden of disease that disproportionately affects society's poorest is to build systems of service delivery targeting those marginalized. In this sense, human rights legislation and health law cannot be conceived of in isolation; the state's role remains to ensure essential health care access for all of its citizens.

In the case of cookstoves, an epidemic of lung disease and acute respiratory infections is intimately linked to the low social status of the women who have no choice but to spend hours every day using rudimentary methods of cooking in small and

unventilated homes. Decreasing indoor air pollution requires addressing this social reality through a commitment to rights protection, along with an acknowledgment of the fundamental notion that society has a responsibility to ensure health care access for all, especially for those disadvantaged.

Thus, the state's role as a duty bearer becomes one of fulfilling and protecting its citizens' right to health. For those rights-holders that have their own means to access care, the state's role can be facilitating, in creating demand for services and supporting the private sector market environment that will ensure supply. But the private sector by itself cannot guarantee health care, nor should its inherent profit-driven disposition be expected to reach those living in rural poverty. When marginalized people lack the resources to act on their needs or when market failures inhibit supply, the state, as a duty bearer, may become a provider of health care services, either through the private sector or directly. Even if the state lacks resources to take on such a role, it is obligated to divert resources from other programs or seek international resources to fill the resource gap.

This should be the case for indoor air pollution, with the state fulfilling and protecting its citizens' right to clean air. Government's role in general could be as facilitator of private sector ICS service delivery, while more assertively and directly providing ICS services for the targeted poor that the market fails to reach. In addition to the principle of equality, a rights-based approach to the provision of clean indoor air includes the principle of accountability. The state should ensure that all citizens have access to clean indoor air, and that targets are set and monitored so that the state can be held accountable for the realization of this right.

Ongoing monitoring of the prevalence of indoor air pollution-related illnesses should be the primary method of accountability. Repeated health-recall surveys, biometric measurements, and physical exams should be used to monitor health outcomes. Potential metrics include household and individual carbon-monoxide-exposure levels, lung functioning, and physician- or health worker-diagnosed disease including acute respiratory tract infections and emphysema, particularly among women and children. In addition to health outcomes, usage rates of ICS are also important to monitor. Household surveys should measure the primary outcome of the proportion of time in which a household with an ICS uses it properly and as its only cookstove, while potential secondary outcomes include time spent on fuel collection, money spent on fuel, numbers of meals cooked, time and money spent on maintenance activities, and attitudes about and satisfaction with stoves among users.

Ultimately, data collected should elucidate the relationship between high rates of ICS use and low prevalence of indoor-air-pollution-related illnesses. Regular monitoring holds governments accountable to targets, and would clearly illustrate whether or not a government is fulfilling its role in protecting its citizens' right to clean air.

In an implementation of a human-rights based approach, a large cadre of trained and appropriately compensated health care workers, under the provision of the state, could help create the demand for ICS at the community level through various promotion and education campaigns. Further, these health care workers could act as facilitators or providers of ICS services to those communities where market failures inhibit supply, while also continuously carrying out monitoring and evaluation of ICS programs.

A human rights approach to indoor air pollution increases access to ICS services in order to make available to citizens their right to clean air. At the core of the rights-based approach is the acknowledgement that reaching those living in rural poverty requires significant state investment and resources in order to fulfill the universal right to clean air. Governments must take ownership in the form of financing, facilitating, regulating, and monitoring, and they must continuously be held accountable. The use of government community health workers has the very real potential to turn the comprehensive right to clean air—and more broadly, the right to health—from rhetoric to reality.

EXAMPLE OF NEPAL: AN OPPORTUNITY

Nepal faces a deep and widespread problem of indoor air pollution, since biomass usage is prevalent. A 2011 national survey indicated that 83% of households in Nepal live in rural areas, with roughly 92% of that number reporting use of firewood for fuel.[29] Consistent with findings in other rural settings around the world, indoor air pollution has been shown to be a major indicator of diseases such as chronic bronchitis, chronic obstructive pulmonary

disease, and acute respiratory infection.[30] A 2007 report published by WHO estimated that there are 7,500 annual deaths and 204,400 disability-adjusted life years in Nepal directly associated with biomass use, accounting for up to 2.7% of the national burden of disease.[31]

Also consistent with similar cases around the world, efforts to implement ICS in Nepal have had limited success. Programs in the 1970s led by international non-governmental organizations and United Nations agencies came to a standstill due to insufficient funding, and national programs to promote ICS in the 1980s failed as the stoves proved not to be durable.[32] A review of a series of studies from as recent as the early 2000s showed that ICS programs in Nepal had inconsistent and inconclusive results.[33]

However, a relatively recent resurgence in ICS has led to the development of new programs headed by the Alternative Energy Promotion Center (AEPC), a semi-autonomous government body under the Ministry of Science, Technology, and Environment. AEPC's efforts are aimed at building community, district, and national capacity to promote ICS. AEPC has pragmatically stressed the importance of public-private partnerships and involving women in ICS interventions.[34]

Nepal's health policy environment since the end of civil conflict presents an opportunity to implement a rights-based approach to this problem of indoor air pollution. In the wake of a decade-long war that ultimately deposed the king and created a constitutional democracy, health care policy was written to include, for the first time, bold, rights-based language.[35] Labeling clean household air as a human right therefore puts demands on the government to fulfill its role as a duty bearer, either as a facilitator or more direct provider of ICS services. It also allows citizens as rights-holders to demand access to quality ICS services and to hold their government accountable.

In addition, Nepal has one of the more developed community health worker networks in the world. The government program was started in 1989 and now totals over 52,000 Female Community Health Volunteers (FCHVs) covering nearly every village in Nepal. FCHVs represent a resource to be utilized for positive behavioral change by 1) ensuring the building of a knowledge-based demand for ICS as a remedy to indoor air pollution, 2) encouraging a rights-based demand for ICS services, 3) facilitating the private sector's engagement in meeting that demand, 4) ensuring the progressive provision of such services through direct action of the state when marginalization so dictates, and 5) monitoring these programs to hold government accountable to its targets.

Given this background, we suggest practical steps for a rights-based approach to the problems of indoor air pollution in Nepal are to:

- provide a clear mandate for government investment in public and private sector implementation and regulation of indoor air pollution technologies;
- incorporate indoor air quality within the national pantheon of essential public health services akin to clean water, vaccinations, family planning, and primary care; financed through local, corporate, bilateral, and governmental bodies; and implemented through private and public-private partnerships;
- establish the role of government in monitoring, via household and other surveys, the extent of the indoor air pollution problem and gaps in ICS service availability, quality, and uptake, as part of general public health surveillance, similar to maternal and child health, infectious diseases, and road traffic accidents;
- build demand for ICS services by utilizing FCHVs overseen by their local district health offices in public sector promotions programs; and
- target efforts to regions where indoor air pollution causes harm yet where the ICS market does not reach, and in such cases shift the government's role from facilitators to direct ICS service providers.

Encouragingly, the Nepali government announced earlier this year, 2013, an ambitious mission to achieve "Clean Cooking Solutions for All by 2017." Multiple rounds of discussions with major stakeholders, led by the AEPC, recognized the need for a coordinated national alliance to achieve the 2017 target. On July 10, 2013, a task force comprised of the AEPC, private sector companies, and development partners declared the establishment of the Nepal Alliance for Clean Cookstoves (NACC), an affiliate of the United Nations Foundation's Global Alliance for Clean Cookstoves (GACC).[36] The NACC's establishment—with its stated approach of acting as a centralized,

national resource for facilitation and information sharing of product improvement, financing, understanding of market dynamics, enhancing of demand, and creating of an enabling environment—is an opportune first step to addressing pragmatically the long-standing problem of cookstove-induced indoor air pollution. Under this framework, Nepal's vast network of FCHVs could become a serious catalyst towards the fulfillment of the right to clean air. As of yet, there exists no coordinated effort to incorporate ICS programs within the purview of FCHVs.

CONCLUSION

The global community faces a critical moment in the fight against indoor air pollution. There is global consensus, awareness, and mobilization around the need to act. National and international collaboration platforms, including the NACC and GACC, have been established. Partnerships across civil society groups, service delivery organizations, donors, and governments are being forged. Past failures have been acknowledged and efforts to address them are being made. Simultaneously, the concept of health as a human right has been a compelling one whose adoption has, over the past few decades, improved and saved the lives of many.

Now is the time to recognize access to clean air as a crucial component of access to health, and as a human right that is well within governments' mandate to fulfill. The rights-based approach to clean indoor air provides an important perspective that underlines the role that governments have in mitigating the effects of indoor air pollution on their citizens, with an emphasis on progressive improvements for the marginalized whose very lives are threatened by indoor smoke.

The technology of our time has made possible the fashioning of cost-effective solutions to many different problems encountered in developing countries. But technology, by itself, has rarely been enough to eliminate these problems. It is crucial to recognize that fundamental structural injustices that disproportionately affect the poor must be addressed with the broader aim of bettering the larger systems of service delivery. In the case of cookstoves, there is wide acceptance that technologically improved stoves have great potential to reduce sickness, lessen harm to the environment, and open up economic opportunities for those living in poverty. But that potential will remain unmet if the realities of the poor—that ICS markets may not reach them, that they lack information about ICS, that maintenance is far more difficult to achieve in rural settings—are not acknowledged and pragmatically addressed. The rights-based approach makes clear the extent to which the state must act to ensure clean air for all.

Finally, the rights-based approach highlights the potential importance of community health workers and public-private partnerships in implementing effective interventions to lessen the burden of indoor pollution. Governments must take ownership of such issues and invest significant resources—through their own means and by collaborating with various public and private organizations—to provide access to clean air. There currently exists infrastructure in some areas that is appropriately suited to facilitate the delivery of these services. Community health workers are well positioned to provide the support that these programs require to succeed, in regards to demand creation, implementation, and monitoring. In such a way, these health workers provide a mechanism to enforce equality and accountability, key aspects of the rights-based approach.

The latest advances in Nepal regarding the coordinated efforts to achieve "Clean Cooking Solutions for All by 2017" represent the dawn of a government-led, right-based approach that could be a world leader in addressing the deadly issue of indoor air pollution. The country's health policy environment, the vast network of FCHVs, and, most importantly, the demonstrated will to invest in such initiatives, is certainly promising. Maintaining a close watch on its progress may indeed display a public model epitomizing the implications of realizing clean air, and thus health, as an essential and uncompromised human right.

REFERENCES

1. T. Adler, "Better burning, better breathing: Improving health with cleaner cook stoves," *Environmental Health Perspectives* 118/3 (2010), pp. 124–129.

2. World Health Organization, *Estimated deaths and DALYs attributable to selected environmental risk factors* (Geneva: WHO, 2007).

3. T. Bond, C. Venkataraman, and O. Masera, "Global atmospheric impacts of residential fuels," *Energy for Sustainable Development* 8 (2004), pp. 20–32.

4. S. Akbar, D. Barnes, A. Eil et al., *Household cookstoves, environment, health and climate change: A new look at an old problem* (Washington, DC: World Bank, 2011).

5. M. Ezzati, A. Lopez, A. Rodgers et al., "Selected major risk factors and global and regional burden of disease," *Lancet* 360/9343 (2002), pp. 1347–1360.

6. Global Alliance for Clean Cookstoves, *Igniting change: A strategy for universal adoption of clean cookstoves and fuels* (Washington, DC: United Nations Foundation, 2011).

7. K. Smith, S. Mehta, and M. Maeusezahl-Fuez, *The global burden of disease from household use of solid fuels: A source of indoor air pollution* (Geneva: WHO, 2004).

8. World Health Organization, *A WHO plan for burn prevention and care* (Geneva: WHO, 2008).

9. S. Lim, T. Vos, A. Flaxman et al., "A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions," *Lancet* 380/9859 (2010), pp. 2224–2260.

10. Akbar et al. (see note 4).

11. T. Bond, E. Bhardwaj, R. Dong et al., "Historical emissions of black and organic aerosol from energy-related combustion, 1850–2000," *Global Biochemical Cycles* 12/2 (2007).

12. A. Martin, "Environmental conflict between refugee and host communities," *Journal of Peace Research* 42/3 (2005), pp. 329–346.

13. United Nations Women Watch, *Women, gender, equality, and climate change* (Geneva: UN Women Watch, 2009).

14. S. Dutta, "Energy as a key variable in eradicating extreme poverty and hunger: A gender perspective on empirical evidence on MDG #1," in *DFIC/ENERGIA project on gender as a key variable in energy interventions* (London: UK Department for International Development, 2005).

15. Women's Refugee Commission, *Beyond firewood: Fuel alternatives and protection strategies for displaced women and girls* (New York: Women's Refugee Commission, 2006).

16. Global Alliance for Clean Cookstoves (see note 6).

17. J. Lewis and S. Pattanayak, "Who adopts improved fuels and cookstoves? A systematic review," *Environmental Health Perspectives* 120/5 (2012), pp. 637–645.

18. K. Smith, J. McCracken, M. Weber et al., "Effect of reduction in household air pollution on childhood pneumonia in Guatemala (RESPIRE): A randomized controlled trial," *Lancet* 378/9804 (2011), pp. 1717–1726.

19. M. Nicholls, "Novozymes targets multi-billion dollar African charcoal market with green alternative," *Environmental Finance* (2011).

20. T. Wood and S. Baldwin, "Fuelwood and charcoal use in developing countries," *Annual Review of Energy* 10 (1985), pp. 407–429.

21. United States Agency for International Development, *Black carbon emissions in Asia: Sources, impacts, and abatement opportunities* (Washington, DC: USAID, 2010).

22. P. Wilkinson, K. Smith, M. Davies et al., "Public health benefits of strategies to reduce greenhouse-gas emissions: Household energy," *Lancet* 374/9705 (2009), pp.1917–1929.

23. Bond et al. (see note 3).

24. G. Hutton and E. Rehfuess, *Guidelines for conducting cost-benefit analysis of household energy and health intervention to improve health* (Geneva: WHO, 2006).

25. R. Hanna, E. Duflo, and M. Greenstone, "Up in smoke: The influence of household behavior on the long-run impact of improved cooking stoves," MIT Center for Energy and Environmental Policy Research Working Paper (2012).

26. Smith et al. (see note 18).

27. Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19 June–22 July 1946,*Official Records of the World Health Organization,* no. 2, p. 100.

28. A. Suri, J. Weigel, L. Messac et al., "Chapter 9: Values and global health" in P. Farmer, A. Kleinman, J. Kim, M. Basilico (eds), *Reimagining Global Health* (Berkeley and Los Angeles, California, USA: University of California Press, 2013).

29. Nepal Central Bureau of Statistics, *National population and housing census 2011* (Kathmandu, Nepal:

National Planning Commission Secretariat, 2012).

30. M. Pandey, N. Regmi, R. Neupane et al., "Domestic smoke pollution and respiratory function in rural Nepal," *Tokai Journal of Experimental and Clinical Medicine* 10/4 (1985), pp. 471–481.

31. World Health Organization (2007, see note 2).

32. R. Myles and S. Nathan, *Manual on renewable energy technologies for sustainable energy solutions to reduce poverty in South Asia* (New Delhi, India: International Network for Sustainable Energy–South Asia, 2007).

33. M. Nepal, A. Nepal, and K. Grimsrud, "Unbelievable but improved cookstoves are not helpful in reducing firewood demand in Nepal," *Environment and Development Economics* 16/1 (2011), pp. 1–23.

34. M. Basnyat and S. Shrestha (ed), *Government policy and strategies of improved cook stove for dissemination in Nepal* (Kathmandu, Nepal: Alternative Energy Promotion Center, 2003).

35. World Health Organization, *The right to health in the constitutions of member states of the World Health Organization: South-East Asia Region* (Geneva: WHO, 2011).

36. S. Rai, *Background paper for clean cooking market place 2013, Nepal* (Kathmandu, Nepal: Alternative Energy Promotions Center, 2013).