



A smoke-free kitchen: initiating community based co-production for cleaner cooking and cuts in carbon emissions



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ABSTRACT

Cooking over open fire with solid fuels results in incomplete combustion and indoor air pollution (IAP) causing respiratory and other diseases leading to nearly two million premature deaths per year. In urban areas, IAP interacts with outdoor pollutants in toxic chemical mixtures affecting also other citizens and damaging regional air quality in terms of 'brown clouds'. Deaths result mainly in women, children and infants, who are directly exposed to smoke in unventilated kitchens, thus reflecting differentiated and unequal impacts across population groups. Despite the heavy health burden and discomfort, IAP has only recently been recognised as associated with neglected diseases. In search of synergies between adaptation and mitigation, we seek gender sensitive social innovations to halt smoke, soot and early death while reducing deforestation and carbon emissions. Using transition arenas as a participatory method for experiments and social learning we engaged with local entrepreneurs and peasant farmers in sub-Saharan Africa to initiate co-production of efficient flue-piped stoves that save energy, labour and lives. Findings indicate that successful design, production and adoption of improved cooking stoves is possible, but the structural challenges of poverty, inequality and distrust may inhibit further diffusion and more profound processes of social learning. Insights from local studies must therefore be contextualised into broader understandings, as attempted here, while local adoption must be combined with wider initiatives and government policies into complex micro-to-macro solutions that provide forceful effects against IAP and its drivers.

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1. Introduction: cooking and coughing in the context of climate change

Global inequality is a main cause of both overconsumption and underconsumption (Jönsson et al., 2012). It drives food insecurity, ill-health, hazardous living conditions and social conflicts within and between population groups. It interacts with social, technological, environmental and climate change in complex and ethically problematic ways (Rogers et al., 2012). As such it is at the root of the multi-scalar issue of indoor air pollution (IAP) causing discomfort, disease or even premature deaths for local users of inefficient cooking stoves while exacerbating regional and global climate change. In addition, dangerous reproductive work, like cooking over open fire, is conditioned by gender norms defining productive and reproductive rights and responsibilities while regulating access

to labour-saving devices, clean technology and health improving innovations. In response, and as seen in this journal, recent research on livelihoods in the context of climate change, water scarcity and ill-health explicitly underlines the importance of gender and women's agency (Figueiredo and Perkins, 2013; Gabrielsson and Ramasar, 2013). In this article, and like other gender informed research in the climate change debate (Terry, 2009), we stress gender as one of several intersectional inequalities operating at the nexus of poverty, ill-health, environmental degradation and climate change.

Cooking over open fire with solid fuels has long been recognised as a serious health problem (Bruce et al., 2000; Padmavati and Pathak, 1959). Since at least the mid-1970s the use of wood fuel has been known as a major driver of deforestation (Eckholm, 1975; Manibog, 1984). Further, the incomplete combustion from cooking over open fire is now understood as an important source of greenhouse gas emissions (Ludwig et al., 2003). However, despite the longstanding recognition of the multiple and accumulative consequences of this technology (Turner et al., 1990), the situation for stove users has not improved much (Kodgule and Salvi, 2012). In a previous article, we analysed how the many problems associated

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with cooking over open fire have been framed historically in terms of deforestation, energy-efficiency, ill-health and a heavy work burden (Jerneck and Olsson, 2011). Further, we have discussed in more detail how agroforestry can be a remedy against deforestation while serving as a profitable activity for ‘opportunity seeking’ peasant farmers in subsistence agriculture (Jerneck and Olsson, forthcoming-a, forthcoming-b). In this article we will show how solutions to IAP must be tackled in a gender sensitive mode, including women’s and men’s agency, in order that both uptake and the continued use of a cleaner cooking technology can take place.

2. Smoke, soot and sufferings

Every day throughout the global South people who are poor, and some who are not so poor, cook on simple stoves in rural, urban and peri-urban households. In window-less and poorly ventilated kitchens, women spend hours preparing meals for their family. Squatting on mud floors they stir their clay pots and metal pans over an open fire encased by three stones, often meanwhile tending small children and, from time to time, carrying a baby strapped on the back. Silently they endure the smoke. It irritates their eyes and creeps into their lungs, hour after hour, day after day.

In magnitude, half the global population depends in this way on solid fuels like wood, dung, coal and agricultural residues for everyday cooking, heating and lighting (Grieshop et al., 2011; Rehfuess et al., 2006; Torres-Duque et al., 2008). Further, it is predicted that another 200 million people will rely on biomass for cooking and heating by 2030 (Warwick and Doig, 2004). The use of low-grade fuels on energy-inefficient and poorly ventilated cooking stoves, as described here, results in incomplete combustion and indoor air pollution with dire health hazards for stove users (Rehfuess et al., 2006) thereby causing a high disease burden, disability and premature deaths (Fullerton et al., 2008).

Until recently (1984), respiratory disease was the main cause of death in many countries (WHO, 2010b). As of 2010 the main killer in low-income countries is a communicable disease like HIV, malaria or diarrhoea (WHO, 2010a) but every year at least 1.6–1.8 million people die of respiratory diseases caused by IAP from cooking over open fire, corresponding to four percent of the global burden of disease (Torres-Duque et al., 2008). Pollutants from inefficient solid fuel combustion cause or exacerbate a whole series of illnesses (Naeher et al., 2007) including both respiratory and non-respiratory diseases (Fullerton et al., 2008). The majority of the victims are women and children (WHO, 2002) who are disproportionately exposed and afflicted, through daily spending hours near the fire (Po et al., 2011). IAP therefore poses a severe public health problem, especially for children and infants, who both absorb more pollutants and retain them longer, thereby putting their lives at risk (Budds et al., 2001). Because a young child has small lungs it breathes faster than an adult, thus risking more extensive inflammation from inhaling the smoky air. This may cause serious damage to its immune system (Warwick and Doig, 2004) or even fatal acute lower respiratory infection such as pneumonia (WHO, 2002).

In urban areas, IAP interacts with outdoor pollutants in complex ways producing a toxic mixture of chemicals affecting both the users and other city dwellers (Kadir et al., 2010). In addition to the immediate impact on stove users and the local air quality in the form of IAP and urban smog (Worobiec et al., 2011) the regional air quality is influenced at very large distances from the main source contributing to ‘brown clouds’ (Brunekreef, 2010). In addition, smoke in the form of black carbon (=soot) from incomplete combustion of solid fuels ranks as the second or third most important contributor to climate change with a global warming potential several magnitudes greater than CO₂ (Tami and Sun,

2005). As an aerosol, smoke has global climate impacts as well as decisive regional climate effects on precipitation (Rotstayn and Lohmann, 2002) and on temperature in the form of heat waves (Stott et al., 2004; Tressol et al., 2008). But, while it takes many decades for the effects of reductions in CO₂ emissions to become apparent (Grieshop et al., 2009), reductions in the emissions of smoke would have immediate effects and beneficial synergies all the way from an individual and local scale to regional and global levels. In sum, the smoke from household cooking, heating and lighting over open fire implies huge individual discomfort and suffering. Notably, the exposure and sensitivity to IAP is extremely differentiated across population groups hitting women and children the hardest. This makes it a clear example of intersectional inequality that deserves due attention. We argue that in the context of the climate change debate IAP amounts to a collective social problem of global health and environmental justice.

3. Sustainability science as a critical problem solving approach

In sustainability science we recognise the multi-scalar complexity and dynamics of climate change, energy use, global health and environmental justice (Jerneck et al., 2011). Using a political ecology frame compatible with sustainability science, we identify indoor air pollution from household cooking not only as a local issue with local effects but as a major neglected issue to be discussed in relation to climate change responses, global health policy, gendered technologies and intersectional inequality. To that end we see poverty and ill-health as multiple stressors in the context of environmental and climate change. In line with that, we agree with John Urry in his plea for a ‘resources-sociology’ that examines the wider social-ecological relations of resource use including energy use (Urry, 2011). First, we identify four decisive shifts in global health funding and the implications of that for the prevention and treatment of the neglected diseases following from IAP. Secondly, we offer a brief account of the historical responses to IAP. Thirdly, we identify three intersectional inequalities associated with IAP and discuss the gendered conditions of production, reproduction and technology in relation to cooking and energy. From a gender sensitive and critical problem-solving perspective, we look for combined social–ecological benefits from improved cooking stoves while aiming at adaptation-to-mitigation synergies at local to global scales. Drawing on repeated field research 2007–2010 on subsistence agriculture in twelve villages in western Kenya (Jerneck and Olsson, 2012; Olsson and Jerneck, 2010), we focus on co-produced and concrete ways to reduce the suffering from IAP in the context of small-scale farming in sub-Saharan Africa. Finally, we place our findings in a wider debate on synergies between, and policies for, climate mitigation and adaptation (Lemos et al., 2007).

4. Poverty, inequality and ill-health in times of climate change

Despite the vast and increasing scientific knowledge about climate change, how to define *dangerous* climate change is still an open, much debated and pivotal question in global climate change policy (Oppenheimer and Petsonk, 2005). Since climate change will be especially detrimental to people who are poor in the global south (IPCC, 2007) the answer must refer to actual adaptation capacity in the world’s most vulnerable areas and communities such as rural sub-Saharan Africa where small-scale farmers depend on rainfed agriculture. Their food, health and water will be at risk while their wellbeing is predicted to worsen due both to climate change and environmental conditions like land use change and land degradation (Andersson et al., 2011; IPCC, 2007). In addition,

climate change policy is increasingly interlinked with food and energy policies. This may provide new opportunities for (some) farmers to diversify their livelihoods into the production of biofuels but it will also compete strongly with food production and aggravate the food security situation in sub-Saharan Africa (White and Dasgupta, 2010). At the same time, global health policies and funding arrangements are changing profoundly with implications for how and to what extent climate change-induced health challenges and neglected diseases, like IAP, can be met (Esser, 2009).

The funding for global health has increased decisively since about 2005 (McCoy et al., 2009) and global health is improving in many respects (Beaglehole and Bonita, 2009). The UNDP, UNFPA and the World Bank joined the WHO in a major initiative to reduce maternal mortality (WHO, 2009) and from 1990 to 2008 the global maternal mortality dropped by one third to around 350,000 per year (WHO, 2010). Further, the international development community including the WHO, the World Bank and the United Nations has reacted forcefully against the contemporary large-scale health crisis caused by the three major infectious diseases of HIV–AIDS, malaria and tuberculosis, which plague large parts of the population in many developing countries (UN, 2000). The three big epidemics of HIV/AIDS, malaria and tuberculosis still receive eighty percent of the total global funding for neglected diseases (Moran, 2005), however, while a range of neglected tropical diseases, like those related to IAP, have only benefited marginally from the recent surge in global health funding (Hotez et al., 2007). Health improvement is therefore particularly important in tropical regions like sub-Saharan Africa where large populations relying on rainfed agriculture are vulnerable to climate variability and change at the same time as being subject to poverty, ill-health and land use changes which reinforce each other (Shuman, 2010). In addition, globalisation puts further pressure on small-scale farmers who are thus said to be subject to *double exposure* (O'Brien and Leichenko, 2000).

5. New directions in global health

Overall, we identify four main strategic organisational shifts in global health, which may seriously affect both adaptation to climate change and any serious effort to address neglected diseases like those related to IAP. First, there is a shift away from *comprehensive care* towards specialised health care focussing on specific diseases (Ollila, 2005). Secondly, there is a shift away from *preventive care* towards curative health care (Esser, 2009). Thirdly, there is a shift from *state agencies* to public-private and private actors as agenda-setters and funders (Ollila, 2005; Prah-Ruger, 2007); and fourthly, there is a shift away from *health agencies* in favour of financial actors as policy drivers (Koivusalo, 1999). Such prolific changes in funding arrangements and ownership within global health, including sourcing and allocation, represent a shift away from the ambition to offer comprehensive and preventive public health care towards a more narrow focus on curing particular diseases. From a private corporate view the sale of pharmaceuticals for curing diseases is potentially much more profitable than preventing ill-health, especially if millions, even billions, of people become potential customers in the expanding global pharmaceutical market. Similarly, from a private corporate view the prevention of respiratory diseases caused by IAP is not a global health policy priority, hence making it a neglected issue.

Regarding smoke, soot and IAP there are no easily identifiable commercial benefits from preventing respiratory diseases through a promotion of smokeless cooking because IAP is mainly located in rural and semi-urban areas where people who are poor spend little money in the market in absolute terms. We argue that in the absence of a large corporate beneficiary who could reap the

benefits of developing or distributing improved cooking stoves, decisive global initiatives such as those for HIV/AIDS, malaria and TB are unlikely to emerge. Yet, in order to promote the use of biogas stoves and the design of improved biomass stoves, the United Nations Foundation has at last initiated a 'Global Alliance for Clean Cookstoves' in collaboration with country partners, civil society, NGOs, donors and UN agencies including the WHO as a leading partner (WHO, 2010a). This takes us to the attempts made over time to tackle various aspects of the incomplete combustion of biomass.

6. Responses to energy inefficiency, deforestation and smoke related ill-health

Historically, the interest in improved stoves focused on increased energy efficiency to reduce deforestation and greenhouse gas emissions. In India in the 1940s, Gandhi initiated dissemination programs for flue-piped cooking stoves to reduce the indoor smoke. In South Asia in the 1970s, development organisations tackled deforestation and excessive reproductive work spent on fuel gathering, through programs for fuel-efficient cooking stoves (Eckholm, 1975). In the 1980s this was followed up, also in China, and supported by international aid organisations in several research-based interventions measuring smokiness and energy efficiency (Reid et al., 1986). As regards the health burden, researchers reported already in the 1970s and 1980s that cooking over open fire yields high emissions of certain respirable particulates and dangerous pollutants causing chronic obstructive lung diseases like bronchitis (Reid et al., 1986). It was not until the 1990s, however, that the World Bank took a broad perspective and recognised that improved stoves would generate economic, environmental and social benefits (Barnes et al., 1994).

Currently, researchers pay increasing attention to the health hazards for women and children who are particularly exposed to dangerous gases, particles and compounds and how this may cause a variety of diseases such as asthma, cataracts, chronic obstructive pulmonary disease, lung cancer, pneumonia and tuberculosis as well as lower birth weight for infants (Ezzati and Kammen, 2002; Po et al., 2011; Smith et al., 2000; WHO, 2002). But in spite of all the problems associated with IAP and the use of simple stoves – ranging from heavy work load, low fuel efficiency, rapid deforestation, high aggregated emissions and high disease burden – the progress in sub-Saharan Africa towards lasting improvements in low technology indoor cooking practices is slow. This indicates that IAP remains a serious issue of global health and environmental justice.

7. Intersecting inequalities

Both the discomfort and death toll from IAP reflect spatially and structurally determined injustices with visible and measurable intersectional inequalities along the lines of age, class, gender and space. IAP divides the world into those who depend on an outdated technology imposing a serious burden on the users including the risk of a deadly disease plus the economic pressure, psychological stress and physical burden from medical treatment – and those who do not. Further, there is a division between men and the large number of women and children who are exposed daily, for several hours, to the smoky air in poorly ventilated kitchens (WHO, 2002). Despite the magnitude of the health problem of IAP, including the fact that it kills twice as many people annually as malaria (WHO, 2010a), it has received very little global attention in terms of policy, funding and interventions. Despite all inherent hazards and inequalities from IAP it remains *invisible* and one of the most neglected issues in the global South, not the least since

household cooking and manual biomass collection is generally performed by unpaid women and children in the *informal economy* of rural areas thus falling outside national accounts of energy use, labour and production.

To sum up, there are at least three types of inequalities: *international* inequality, as it afflicts the global South; *intersectional* inequality, as it is overwhelmingly performed by certain social groups in terms of sex and space such as women in rural areas; and *intergenerational* inequality, as it entails huge risks for infants and children whose cooking mothers mind their offspring thus performing dual reproductive and gendered responsibilities simultaneously. These inequalities are particularly problematic since globalisation increases the expectations on social equality (Beck, 2010). Likewise, development and sustainability increase the expectations on wellbeing as 'doing and feeling good and well' in both material and immaterial terms (Jönsson et al., 2012; Rogers et al., 2012; White, 2010). Such wellbeing, as we see it, is constituted in social interaction. Necessarily, it refers to individual and lived experiences in everyday life but it certainly also involves social norms, values and culture, which are all situated and need to be well understood and addressed profoundly.

8. Technology and gender

The diffusion of modern technology takes place in numerous processes that transform production, services and social relations in society at large, yet at different speeds in different domains. Technology is embedded in socio-ecological relations and exists in the gendered micro-processes of everyday lives (Clancy et al., 2003). The kitchen domain, often seen as feminine space, is located at the very heart of the reproductive sphere often governed by ancient norms. As observed by Boserup (1970), areas dominated by female labour are slower or often neglected in terms of technological improvement and innovation. Although women as managers of heavy and time-consuming biomass collection have developed fuel-efficient cooking practices (Clancy et al., 2003) these new energy saving devices may not necessarily meet the needs of a special 'place' for preparing meals, sheltered from multiple problems other than smoke. Despite the discomfort and health hazards caused by smoke from indoor cooking it may still be preferred to outdoor cooking if it offers privacy and safety, protection from animals and dirt or theft as well as shelter from wind, rain or heat from a scorching sun. Hence, reproductive work in the private sphere – like health hazardous indoor cooking – should be examined in relation to the public sphere (Elson, 2000) and the gender regimes of energy, labour and power within and beyond the local context (Lim and Tinker, 1990).

Given the prevailing gendered division between productive and reproductive labour, the provision of improved cooking stoves and smoke-free kitchens would constitute a synergy between several Millennium Development Goals (MDGs) (Zhou et al., 2011), ranging from reduced infant mortality and enhanced gender equality to forest preservation, environmental sustainability and emissions reductions (Warwick and Doig, 2004). A successful technological shift in cooking equipment could address five of the eight MDGs directly, primarily by lowering the health hazards for children and mothers (MDG 4–5), but also by improving gender equality, reducing deforestation and mitigating global climate change (MDG 3, 6–7). If women's and children's time spent on firewood collection is redirected towards income generating and food-securing activities alongside children's increased school attendance that would promote the MDGs on poverty reduction (MDG 1) and primary education (MDG 2) (Warwick and Doig, 2004; WHO, 2010a). Research also indicates that interventions for improved cooking practices can contribute to improved health even if the

adherence among community members may vary or be low (Naeher et al., 2007). Given all the synergies and potential co-benefits of broad initiatives it is hard to explain why smoke-free kitchens are not more readily available. The literature therefore suggests that one way forward is to further involve and inform decision- and policy-makers (Naeher, 2009). In addition, we initiated a co-production project with cooking stoves users in a community based effort to tackle the smoke.

9. Global to local synergies

Besides the direct human and local problems caused by smoke and IAP, the black carbon emissions from indoor cooking are warming the atmosphere at regional and global scales (Ramanathan and Carmichael, 2008). Hence, synergetic solutions should engage with critical local issues of poverty, ill-health and deforestation while seeking potential co-benefits such as climate change mitigation (Olsson and Jerneck, 2010). The international climate change regime contains several mechanisms for the provision of clean energy, particularly the Clean Development Mechanisms (CDM). Paradoxically, the CDM does not cover such straightforward activity as the provision of smoke-free cooking stoves for the poorest of the poor. This is unfortunate, but not surprising, especially since it is rarely recognised that people who are poor are significant emitters of greenhouse gases through wood combustion (Olsson and Jerneck, 2010). Wood fuel is indeed a renewable source of energy, but whenever the consumption of wood is greater than the re-growth of trees and bushes, there is a net emission of greenhouse gases. People, mainly women but also men, who cook over open fire can thus become decisive agents in fighting climate change by lowering their emissions (Olsson and Jerneck, 2010). Notably, such contributions may serve as a global co-benefit of improved local conditions.

Switching to an alternative technology based on cleaner and higher-quality fuels is unfortunately not a real option for cooking stove users who are poor, because of high market prices of the necessary equipment (such as special burners) let alone costly fuels (liquid gas, kerosene) or expensive electricity including its provision (Po et al., 2011; Torres-Duque et al., 2008; Zhou et al., 2011). Research shows that the four main factors influencing the choice of fuel type relate to cost, cooking practices, cultural preferences and health impact (Fullerton et al., 2011). We argue that despite its obvious advantages, solar energy would only serve as a *complement* because it only works outdoor, during a limited time of the day and under clear sky conditions. Under the current gender regime where cooks prefer indoor privacy for various reasons, solar energy is problematic (Wentzel and Pouris, 2007). A more rapid and affordable, yet short term, option would be cooking stoves equipped with a flue pipe that removes the kitchen smoke. This will also create ancillary benefits, such as increased energy efficiency plus notable reductions in everything from deforestation to the danger and discomfort of inhaling smoke and the drudgery of collecting firewood. For peasant farmers who are poor, such an improved cooking stove is a relatively inexpensive investment that guarantees several positive local changes as well as globally reduced greenhouse gas emissions. Having said this, we would envisage a future shift towards a more advanced and longterm technology like biogas.

As a social benefit, adults may spend the time saved on firewood collection on skills development or community interaction while children may increase school attendance. As an environmental benefit, a lower demand for wood fuel may decrease deforestation and increase biodiversity while crop residues or animal dung previously used as fuel for cooking could instead be used as fertilisers to increase crop yields. Improved vegetation status may reduce vulnerability to extreme climate events, such as floods,

while increasing the sequestration of carbon in ecosystems. As an economic benefit, more time can be spent on agriculture or income diversification, especially among those, mainly women, who suffer from 'time poverty' (Blackden and Wodon, 2006). Importantly, expenditures on clinical visits, check-ups (including expensive lung X-rays) and medicine will decrease when women's and children's health status improves. However, time-saving new techniques may actually exert increasing demands on women to perform other and additional labour-intensive tasks, as often noted in feminist and gender sensitive studies (Beneira, 2003). See also Clancy et al. (2012).

10. Gender sensitive engagement with stakeholders

Owing to existing intersectional inequalities in the particular context of small-scale farming, the impact from poverty and environmental change, which everyone is subjected to, are differentiated according to age, gender, ethnicity, etc (Gabrielsson and Ramasar, 2013). Throughout the global south and in accordance with existing gender regimes, the collection of water and firewood for the preparation and cooking of food constitutes a suite of reproductive tasks shared mainly by women (and children). The gendered division of reproductive work is enacted when women (and children) carry out gender-coded activities flowing from historically inscribed, yet changeable, social norms in the local context (Elson, 1991). In line with this gender regime, previous research shows that lasting solutions for smoke-free kitchens depend upon 'the active participation of those at risk, poor women' (Warwick and Doig, 2004). This implies that an improved cooking technology should certainly draw on women's positional knowledge. But households are gendered spaces where men and women have conflicting ideas and interests while sharing and pooling certain resources (Kabeer, 1999). Sustainable solutions must therefore involve both men and women as active problem analysts and problem solvers in a gender sensitive approach to tackle IAP. Such an approach would underline the social injustice of a gendered division of labour that ascribes most unpaid reproductive work to women (and children). It would also highlight the gendered inequality in life expectancy and life opportunities caused by women's higher exposure to dangerous particles in smoky kitchens as well as the societal incapacity to replace traditional with improved cooking stoves, despite the availability of good alternative technologies. Importantly, it would also seek gender-informed solutions to the problem despite possible initial resistance.

In search of sustainable solutions, researchers like Leach et al. (2010) advocate place-based and context-specific frames taking diversity, distribution and social justice into consideration. In an attempt to promote community based action for improved well-being, we initiated a small and co-produced project in western Kenya to design, manufacture and distribute smoke-free kitchens (Jerneck and Olsson, 2011; Olsson and Jerneck, 2010), Fig. 1. The initiative draws on the skills of both female and male community members and is crafted as an attempt to promote collaboration through a local 'community of practice' (Wenger et al., 2007). It operates in the form of a production and business chain based on cooperation and trust among committed members. In this chain a potter crafts the clay stoves, a tin-smith assembles and rivets the flue pipes and a community entrepreneur demonstrates, delivers and installs the new technology for customers while providing credits by means of a revolving fund.

In our co-produced experiments, social change was more profound and consistent when we involved women and men as well as feminine and masculine skills and wisdom in interventions for improved stoves in a smoke-free kitchen (Olsson and Jerneck,

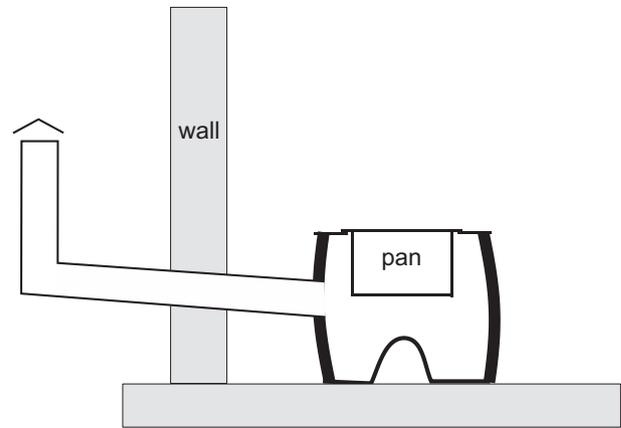


Fig. 1. The improved stove is made of clay from local sources and designed to fit the most commonly available metal pans used for cooking. The pan is lowered into the stove which makes the heating efficient and the smoke escape through the metal pipe. See also Fig. 2.

2010). Hence, both women and men discussed the design and construction of the improved stove and took part in its production, distribution, installation and demonstration, Fig. 2. In order to explicitly involve men in the experiment we reconfigured the kitchen symbolically from a cooking area (a mainly feminine space) into an experimental arena for smoke-free cooking on improved stoves with flue pipes – now designed and reinterpreted as a gender neutral space. By performing a conventional labour repertoire as carpenters and masons building the kitchen, tinsmiths making the flue pipes and facilitators installing the new cooking stoves with flue pipes, men seemed to acknowledge both the material and the immaterial conditions of cooking while appreciating improvements. We found that men became particularly involved as active participants in the experiment when they had the opportunity to listen to the stories told by male elders (or others) who had lost both wives and children to IAP.

The shared experience of constructing and introducing improved stoves and smoke-free kitchens in a gender-mixed 'community of practice' created a certain vital ambiguity in relation to cooking and indoor air pollution that built on, but also challenged, traditional gender norms and identities. Both men and women began to value and understand the long-term implications for health and wellbeing of a smoke-free cooking environment. A new 'symbolic circle' (Strauss, 1959) of 'meaning making' could thus be drawn around the generally feminine reproductive task of cooking over open fire and women's suffering from respiratory disease. Not only was the kitchen reframed (Jerneck and Olsson, 2011), from having been viewed merely as a feminine space, into a gender neutral experimental arena – the improved cooking technology was reframed from mainly serving the purpose of energy and time efficiency in women's food preparation towards an issue of improved health status for community members that would benefit everyone, although women and children, having suffered the most, would benefit relatively more. The very reframing of such particular productive and reproductive rights and responsibilities in subsistence farming can thus, if performed as a gender sensitive joint activity in the community, be a forceful tool for problem definition and for starting a process of problem resolution for cleaner and more sustainable production.

Interventions like this, and as part of transdisciplinary research and knowledge co-production in sustainability science, show that a process of social learning that emerges from experiments may spill over into a new community of practice dealing with other challenges. In times of climate variability and change and in



Fig. 2. Examples from the joint production and business chain for making and installing improved flue-piped stoves. The potter makes the co-designed stove from locally collected clay and prepares the firing using dry grass and maize stover. The facilitator demonstrates a flue-piped stove for a smoke-free kitchen in a nearby community. In late 2012, more than 200 households in nine communities had purchased a stove. LUCSUS illustrates the full process in a film: <http://vimeo.com/9371888>

geographical areas with agricultural drought, water scarcity represents such a real challenge especially in an unequal world where nearly one billion people have limited access to clean water for their daily needs and survival (UN, 2011). Water-harvesting experiments with water tanks show that solutions can be designed locally and distributed in similar networks. But again, household water provision is seen as women's domain (Gabrielsson and Ramasar, 2013). When also men get involved in the design of the water storing equipment and see how a shared responsibility for water entails shared benefits, a new symbolic circle of meaning making could be created also around water. Attempts to understand and tackle sustainability challenges should therefore cut across individual, cultural and structural dimensions in terms of identity construction, symbolic representation and social structures (Harding, 1986). This is especially important when inequalities and practices in the household are perpetuated (and even cemented) as a reflection of the overall division of labour in society. This speaks back to the gender sensitive research on water, climate and agents of change that we mentioned in the introduction (Figueiredo and Perkins, 2013; Gabrielsson and Ramasar, 2013; Terry, 2009).

11. Synergies between adaptation, mitigation and health

According to the IPCC, adaptation to climate change is defined as 'adjustment in natural or human systems in response to actual or expected climate stimuli or their effects which moderates harm or exploits beneficial opportunities' (IPCC, 2007). In the mainstream literature, however, adaptation is often stripped of its social content and discussed mainly in terms of technology, such as climate proofing of infrastructure or in terms of economic tools, such as insurance policies (Linnerooth-Bayer and Mechler, 2006). But adaptation must also be understood in terms of fundamental social change including gender, livelihoods and everyday rural or urban life (Lemos et al., 2007). While adaptation is clearly a first priority for poor communities in the global South some of the most effective adaptation measures may also serve as mitigation strategies (Olsson and Jerneck, 2010; Tschakert and Olsson, 2005) such as agroforestry (Sanchez, 2000), new ecological agricultural practices (Olsson and Ardö, 2002) and smoke-free kitchens (Olsson and Jerneck, 2010). To participate actively in the fight against climate change and to advance international negotiations, it is important to demonstrate how people who are poor, in many ways use their agency to mitigate climate change. For that reason it is crucial to identify, as is attempted here, and to promote synergies of adaptation and mitigation from local to global scales.

12. Conclusion

Smoke from household cooking, heating and lighting has serious short- and long-term effects on billions of people, not least on children, and a lethal impact on nearly two million people per year. Direct effects occur through inhalation while indirect effects result from interference with the regional and global climate. The problem of indoor air pollution exists in many different and varied local contexts and thus has to be addressed in locally appropriate ways. In this article we build on grounded participatory research and co-production to show that reasonably simple and flexible technical and social solutions are generally available and may offer widely shared local to global benefits resulting in improved well-being for people who are poor and climate change mitigation for the global community. All in all, the provision of smoke-free kitchens to poor households could potentially create synergies across social, natural and economic domains (Olsson and Jerneck, 2010).

Due to the structural shifts and the increasingly commercial orientation of the international global health regime, forceful initiatives delivering such solutions are unlikely to emerge. In an attempt to create conditions for knowledge co-production as a way forward to promote local to global sustainability, we identified how joint production and business chains can be created on the basis of local social arrangements. Using our sociological and ecological imagination (Figueiredo and Perkins, 2013) we analysed how environmental and climate change interact with intersectional inequalities (Gabrielsson and Ramasar, 2013). That enabled us to go beyond energy efficiency and the gendered norms of the kitchen sphere. Based on intersectional awareness we demonstrated how context-specific social relations, skills and preferences may serve as a fruitful foundation for installing, using and understanding the multiple benefits of a smoke-free kitchen and improved health in the community.

While this minor initiative illustrates what is possible (and necessary) it is not sufficient. Development research has shown that inclusive and participatory processes often fail if they do not reconsider (and act upon) the underlying structural layers of poverty. Hence, we agree with researchers who explicitly underline the need for multiple initiatives and broader policies on social change (Lemos et al., 2007). In line with this, we agree with researchers who argue explicitly that cleaner cooking technology will have to involve NGOs and government policy (Torres-Duque et al., 2008) and not only, as in our case, researchers, communities, and social entrepreneurs. On a final note, gender sensitive solutions aiming at cleaner and more sustainable reproductive

work, like cooking in a smoke-free kitchen, have a potential to contribute to physical, social and emotional wellbeing as called for in the ongoing debate on sustainability transitions (Rogers et al., 2012).

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