SMART VILLAGES
New thinking for off-grid communities worldwide

Sustainable energy resources for risk management and resilience of communities in Latin America and the Caribbean

Workshop Report 31

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Smart Villages

We aim to provide policymakers, donors, and development agencies concerned with rural energy access with new insights on the real barriers to energy access in villages in developing countries—technological, financial and political—and how they can be overcome. We have chosen to focus on remote off-grid villages, where local solutions (home- or institution-based systems and mini-grids) are both more realistic and cheaper than national grid extension. Our concern is to ensure that energy access results in development and the creation of "smart villages" in which many of the benefits of life in modern societies are available to rural communities.

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Summary

Leading experts from across Latin America and the Caribbean were brought together for a workshop in Quito, Ecuador, on 30 January 2017 to discuss the challenges and opportunities of building resilience to natural disasters of villages in the region, with a particular concern for the contribution of energy services. Key points made in the presentations and discussions are summarised in the following paragraphs.

People living in rural communities and in poverty often return after natural disasters to rebuild in risk-prone areas as they have no realistic alternatives: "you live where you can, not where you want to". Short-term imperatives like having enough to eat take precedence over medium- and long-term considerations of safety. Also, urbanisation may increase the number of people living in vulnerable areas; for example, coastal cities subject to hurricanes and tsunamis, and cities located near to faults at risk from earthquakes. Natural disasters result in 26 million people around the world each year stepping back into poverty.

The resilience and health of human communities and of the ecosystems in which they live are closely interdependent; risk assessments need to consider both together. Similarly, there are strong interdependencies between cities and villages in respect of resilience, not least because of the movement of people between them.

Countries need to establish resilience strategies based on improved knowledge of the risks and identification of the most vulnerable communities. Such strategies need to be developed and implemented in a way that integrates the efforts of all relevant government ministries. In respect of the physical infrastructure, they need to establish building regulations and ensure they are implemented, and put in place prevention and recovery actions. International initiatives such as the Sendai Framework are helpful in establishing objectives and definitions, and supporting international collaboration.

It is important to learn from experiences of natural disasters and to revise policy frameworks and implementing mechanisms accordingly. Such learning is also key at the community level; for example, in Central America rural communities that had come together to rebuild after civil wars were better able to recover from subsequent hurricanes. Lessons can also be learned from traditional technologies and approaches. For example, the systems of agricultural terracing used for many centuries by the Incas were better able to save water and avoid erosion (and hence increase resilience to floods and droughts) than farming techniques imported from Europe.

Communities need to be directly involved in resilience initiatives through an open dialogue that respects cultural beliefs and customs. An important outcome is that the community realises the importance of risk management measures. If they do not, such measures may be rejected. Public-private partnerships can provide an effective mechanism for interventions: the community needs to be closely involved in an oversight role.

Communities that come together to rebuild after natural disasters increase their social ties and capacities to enhance resilience. They tend to have a strong sense of ownership and independence, which are valuable in meeting the challenges of subsequent natural disasters. In contrast, government interventions that provide replacement houses for free may be counter-productive, increasing the vulnerability of the community in the longer term. An issue for all external interventions is how their benefits may be sustained in the longer term.

Risk assessment should be undertaken of electrical installations at the planning stage, and mitiga-

tion measures built in as appropriate. Efforts are currently underway to define minimum standards for the resilience of critical infrastructures. After a natural disaster, it is necessary to undertake risk assessments of electricity infrastructure rather than just replacing existing infrastructure. While one view suggests that the provision of energy services to villages can increase their vulnerability due to their increased dependence on infrastructure that might be destroyed in a natural disaster, small, decentralised electricity systems are flexible and easy to repair and reinstall after disasters.

The losses from natural disasters are often under-estimated, ignoring for example longer-term losses to trade or tourism. Countries should set up a national fund which can be drawn on quickly in the event of a natural disaster. This is preferable to drawing on international loans which can result in high levels of national debt in the longer term.

Introduction

The resilience of rural communities to natural disasters and other shocks is an important issue for smart villages: hard-won development gains can all too readily be lost through natural disasters such as earthquakes, hurricanes, droughts, and floods. This is particularly so for countries in Latin America and the Caribbean which are at risk from a wide range of natural events.

Leading experts from across the region were therefore brought together for a workshop in Quito, Ecuador, on 30 January 2017 to discuss the challenges and opportunities of building resilience to natural disasters of villages in Latin America and the Caribbean, with a particular concern for the contribution of energy services. The workshop built on an earlier workshop held in Singapore by the Smart Villages Initiative which focused on the resilience of rural communities in Asia.

This report summarises the presentations and discussions at the workshop. Copies of the presentations are available at the Smart Villages Initiative's website: www.e4sv.org. Annex 1 of this report presents the agenda for the workshop, and Annex 2 the list of participants.

Ricardo Peña Opening Remarks

With a warm welcome, Ricardo Peña commented on the great interest of the Ecuador government in initiatives such as Smart Villages. Ecuador is constantly seeking to improve; therefore it is of great importance for them to participate in global initiatives like this and contribute their experience of the last few years on the subject of resilience. He invited the participants to enjoy the workshop and the beautiful city of Quito, a world heritage city where visitors can appreciate it safely. Since the 90s the city has been working on risk management and vulnerability reduction in order to create a secure place for citizens and tourists.

John Holmes Opening Remarks

In his opening remarks, John Holmes welcomed workshop participants and explained that the Smart Villages Initiative is concerned with how energy access, when integrated with other initiatives, can support the development of rural communities. But hard-won development progress can easily be lost due to a range of social and economic shocks, and as a result of natural disasters. So a key question is how can we manage such risks and make villages more resilient? And, in particular, how can energy access contribute to increasing resilience? He indicated that these key questions would be addressed at the workshop.

The Smart Villages Initiative: Claudia Canales and John Holmes

Introducing the Smart Villages Initiative, Claudia Canales presented key figures on the lack of access to sustainable energy sources globally: 1.1 billion people do not have access to electricity, and 3 billion people still cook on dirty and inefficient stoves. Many of the 4.3 million people who consequently die prematurely each year from inhaling smoke from cooking are women and children. The Sustainable Development Goals include Goal 7 on energy access, but it is important to recognise that energy access is a key enabler of most of the other Sustainable Development Goals.

Claudia Canales went on to introduce the smart villages concept in which access to sustainable energy acts as a catalyst for development, enabling much-improved provision of local services such as healthcare, education, clean water and sanitation, and the opportunity for new productive enterprises to capture more value from the agricultural value chain. As nearly half of the world's population and 70% of the world's poor still live in rural communities, it is important to have an ambitious vision for their development

analogous to the smart cities concept for urban communities. Technological developments are shifting the balance of opportunities between cities and villages.

The Smart Villages Initiative is identifying the barriers to village level energy access for development and how those barriers can be overcome, communicating new insights and recommendations to policy makers, development bodies, and stakeholders more generally. Through a series of engagement programmes in six regions (East and West Africa, South and South East Asia, South America, Central America, the Caribbean and Mexico) front-line workers in energy access for development are being brought together to discuss the issues.

The Smart Villages Initiative aims to identify the framework conditions necessary for the implementation of local energy solutions in rural communities, and to maximise the leverage of public sector funding in attracting private investment. A key premise is that an integrated approach should be taken at a community level, and an important concern is to establish how the rate of progress through the levels of energy access and development can be substantially increased.

John Holmes went on to recap on key features of smart villages that contribute to increasing their resilience: they have a decentralised infrastructure, they are connected to the outside world through modern information and communication technologies (ICT), they make use of innovative remote service provision for healthcare and education, and the community is empowered and benefits from economic and social development. But all villages face shocks that include a range of natural disasters, economic shocks, conflict, epidemics, and infrastructure failure.

Building resilience to shocks is an important dimension of smart villages, and so the Smart Villages Initiative brought together the energy access and resilience communities of practice in a workshop held in Singapore in May 2016 to discuss the ways in which energy access and other features of smart villages can contribute to resilience. John Holmes went on to summarise the key conclusions of the Singapore workshop.

Taking a broad view, the enhanced prosperity encapsulated in the smart villages concept means that villagers will move from a hand-to-mouth existence to one in which they have economic margins, enabling accumulation of assets and savings. Such assets and savings can tide them over in the immediate aftermath of shocks, and enable re-building afterwards.

More specifically, energy together with ICT supports better training and education, and the ability to share information with others locally, nationally and internationally. This provides the potential to develop skills and knowledge on how to establish physical and social infrastructures that minimise vulnerabilities; for example, building codes and the location of critical infrastructures.

Similarly, energy and ICT enables communication links which mean that villagers can get warnings of impending disasters; for example, imminent hurricanes and, over longer time periods, seasonal predictions of droughts or floods. Improved communication links also support disaster relief after the event. For example, after the Nepal earthquake in April 2015 knowledge of the plight of remote communities was delayed by several days as there was no means to communicate with them.

Enhanced village-level healthcare, with adequate energy supplies and wireless connections to central facilities and information sources, is another inherent feature of smart villages. Provided that such facilities and their energy/ICT services are designed to minimise vulnerability to anticipated risks, they can play a central role in supporting the welfare of villagers in the recovery period after a natural disaster. For example, a key finding after the Nepal earthquake was that villagers were left "in the dark and out of touch". Solar lights with

mobile phone chargers (now costing as little as $5) could have overcome this problem.

The social capital of rural communities—for example, their cultures of mutual support and social networks within and between communities—can be a major factor in enhancing resilience, both in respect of preparing for potential or imminent natural disasters, and also in rebuilding communities afterwards. Such social capital is an inherent feature of smart villages. Smart villages undertake a stewardship role for their local environment which can help minimise vulnerabilities to natural disasters such as droughts (through effective forest management) and storms (for coastal communities, preservation of mangrove forests). Similarly, access to modern financial systems enabled by energy access and ICT can support the implementation of mitigation measures and the accumulation of appropriate "buffer stocks", and rebuilding in the post-disaster phase.

So energy access through enabling the key characteristics of smart villages is important in building the resilience of rural communities to natural disasters. But care needs to be taken in the design of energy facilities to minimise their vulnerabilities to anticipated risks. For example: micro-hydro schemes may be rendered inoperable by droughts and landslides (triggered by monsoons and/or earthquakes); solar and wind facilities may be destroyed by storms; electricity grid connections may be broken in the event of a natural disaster.

John Holmes went on to describe three examples. Ten thousand people were killed in the Nepal earthquake of April 2015 because houses had not been properly constructed: the Nepal government's slogan is now "Build Back Better". Some villages have fared better than others in recovering from the earthquake because they have good social capital with effective governance structures and a spirit of coming together to help each other as a community. Traditional knowledge also has an important role to play; for example, in how to locate infrastructure to minimise the threat posed by landslides. The capacity of the community to deal with a major natural disaster can be enhanced through learning from how to deal with more routine but less impactful events such as landslides.

The Ebola outbreak in West Africa killed 11,000 people and cost billions of dollars, with impacts rippling around the world. The outbreak could have been avoided with the healthcare systems and connectivity envisaged in smart villages, which would have provided for early detection and effective action. The Tuvalu archipelago of remote islands in the Pacific pose distinctive problems of remoteness: it takes several weeks for a ship to get there. So here the emphasis must be on building infrastructure, including energy facilities, which are hardened against the anticipated natural disasters such as storms, and to develop communities which are self-reliant.

Some final points from the Singapore workshop included that the path to resilience is not linear and smooth; there will be many twists and turns along the road. An integrated approach is needed, bringing together energy access initiatives with other aspects of rural development such as healthcare, education, and clean water, and initiatives on resilience. Consideration should be given to the sustainability of initiatives after project completion. Finally, there is a tension between standardised approaches which provide for scale-up, and the need to address the unique circumstances of each community.

Session I

Resilience experiences in Ecuador and the relationship with the energy sector: Ricardo Peña, Secretary of Risk Management, Ecuador

Ricardo Peña presented on the experiences of, and progress in, resilience matters in Ecuador. Ecuador is one of the smallest countries in South America but has the highest population density of the region: around 65 people/km^2 with the majority concentrated in urban areas. Lately, Ecuador has been working hard to understand its response capacity to natural disasters in order to learn from positive experiences of the past. Ricardo Peña emphasised that resilience is not the same as resistance. For example, the city of Bahía de Caraquez resisted many earthquakes before the 1970s. Up until then, concrete was not a common material; but with the construction boom of the mid-70s, many new buildings were built with this innovative (at that time) material. In the earthquake of 1998 the first concrete building collapsed due to the lack of regulation of its building process. In the earthquake of 2016, however, a concrete bridge resisted with great success the tectonic movements, proving that with appropriate regulations those types of structural damage can be avoided.

The earthquake of April 2016 caused substantial damage in every sector, showing that the structures were not sufficiently resistant. However, in terms of resilience Ecuador proceeded in a positive way. After the earthquake, for instance, 1,500 health professionals were sent to the disaster zone to support the health system, attending to 6,247 people in the first 72 hours. In respect of drinking water, the service was stopped due to electricity cuts and the infrastructural damage caused by the ground movements. Post-earthquake evaluations revealed that the supply capacity of drinking water in the affected area had been only 50% of demand before the earthquake: a low percentage that ended up even lower after the earthquake. However, a positive aspect of the tragedy was that it revealed the water supply deficiencies and the poor performance of local governments in providing this service.

In the education sector, the earthquake damaged 325 establishments. Fortunately, the students were on holiday so no lives were lost, but the school year was set to start at the beginning of May so the government had to work fast. With the collaboration of UNICEF, in less than a month the government had built transitory camps for the schools damaged and started the reconstruction of the school buildings. The recovery plan allowed 80% of the children to start the academic year on time.

Regarding electricity supplies, within 48 hours of the earthquake practically the whole system was restored, with the exception of a couple of municipalities. After one month the system was working normally again. There are some doubts, however, about the responsiveness of the electricity grid if the epicentre of the earthquake had been closer to the generation plants. Quito's thermal power plant, for example, has failed assessments of its exposure to hazards. The power plant is located on the slopes of the still active Cotopaxi volcano. The place chosen is highly vulnerable to volcanic eruptions, putting at risk one of the most substantial infrastructure investments of Ecuador.

The damages and losses caused by the earthquake had a cost of US$3,340 million. Before the earthquake, Ecuador had signed opportunely a fund agreement with the Inter-American Development Bank for recovery from natural disasters. Additionally, it established the "State of Exception and Emergency Fund" generated from taxes, international loans, and international charity to help cover the disaster's financial costs.

The earthquake moved forward the government's knowledge of resilience to natural disasters. Lessons learnt from this earthquake allowed the revision of the policy framework for disaster risk management, as well as an improvement to the inspection methods for the resilience of infrastructure. Nevertheless, some Decentralized Autonomous Governments (DAGs) in Ecuador do not possess enough resources to apply these policies, therefore funding remains the main challenge for the country.

Resilience as State Policy: Ricardo Mena, United Nations (UN) Office for Disaster Risk Reduction (UNISDR), Regional Office Las Americas

The presentation of Ricardo Mena started with an overview of the UN's work globally on resilience. He then introduced the new framework for disaster risks reduction. After every natural disaster, the economic losses are rapidly calculated and shared with the citizens. However, those figures never include trading losses and transaction losses, which can be substantial in the longer term. It is estimated that US$300 billion are lost every year worldwide due to natural disasters, but including long-term losses this figure can increase by up to 60%. Furthermore, in Latin America urbanisation rates are high and the number of people living in urban areas is expected to double within the next 50 years. Development patterns of cities have shown that more and more families are settling in zones vulnerable to natural disasters, such as coastal cities which are exposed to hurricanes, tsunamis, and cyclones, and cities close to fault zones which are exposed to earthquakes. Inequality and poverty are considered to be factors of vulnerability as well.

In order to get a better understanding of this dynamic within cities, the UN created new metrics that not only evaluate GDP losses, but also analyse losses related to social expenses. The assessment of these new metrics revealed that in some countries between 20 and 30% of the social development budget is reallocated to recovery from natural disasters, and that after every disaster a substantial number of people step back into poverty again. Therefore, to tackle this problem, the UN created the Sendai Framework for Disasters Risk Reduction. The Sendai Framework is an international agreement that establishes objectives to avoid new risks, diminish the existing ones, and strengthen resilience in communities. It has seven global targets and four priorities for action.

In summary, it seeks to reduce disaster mortality, number of people affected globally, and economic losses from disasters in relation to GDP. It also seeks to increase international cooperation to support developing countries, the availability of, and access to, multi-hazard early warning systems, and disaster risk information. The priorities for action seek to support nations in better comprehending the risks that they are exposed to. The first priority is to understand the risks: Colombia and Mexico have been developing a new metric called "curvas híbridas de excedencia" (hybrid exceedance curves) to calculate the real costs of disaster losses. The second priority is to strengthen disaster risk governance to manage disaster risk at national, regional, and local level. The third priority is to invest in disaster risk reduction for resilience; in other words, to invest in resilience by pulling people out of poverty. And the fourth priority is to enhance disaster preparedness for effective response and to 'Build Back Better'.

The Sendai Framework is intended to be implemented by local governments through the campaign "Mi ciudad se está preparando" ("My city is getting ready"). This is a global campaign that names ten essential aspects to develop resilient cities:

1. Establish a local organisation responsible for increasing resilience

2. Identify, comprehend, and use current and future risk scenarios

3. Strengthen finance capabilities for resilience
4. Pursue resilient urban development and design
5. Safeguard natural buffers to enhance ecosystems' protective functions
6. Strengthen institutional capacity for resilience
7. Understand and strengthen societal capacity for resilience
8. Increase infrastructure resilience
9. Ensure effective disaster response
10. Expedite recovery and build back better

Feed many birds with the same guava: Gustavo Wilches, Externado of Colombia University, Colombia

Gustavo Wilches' presentation clarified some concepts of territorial safety and risks. He started by explaining that a territory is alive and joins together the dynamics of ecosystems and communities. The concept of territorial security is about avoiding ecosystems threatening communities and vice versa. The "Radical Risk Management" study considered eight highly-interrelated factors within the territorial security concept. In each territorial system it is important to recognise these interdependencies and to identify the key capabilities for self-recovery. For example, there are communities which are economically strong but very weak in social aspects, creating important inequality issues. Only by identifying those weaknesses can they be addressed.

Gustavo Wilches used a spider and its web as a metaphor for the territorial concept. The spider makes webs; likewise people create their territories. Resistance is the capability of the spider's web to resist a shock. It is important to highlight that disasters are not natural; people create disasters and nature is just the threat. For example, in Nepal the reason the houses were destroyed in the 2015 earthquake was not because of the earthquake, but rather the poor construction infrastructure due to lax regulations. On the other hand, resilience is the capability of the spider to make the web again. It is important that territories know how to strengthen themselves with their remaining resources after a shock: by analogy, if the spider loses two legs, it has six more to help it recover.

Territories must be strong enough to support important economic changes or population movements. Resilience applies at a personal level as well. People tend to struggle with greater effort when given reasons to fight. A woman in Colombia, for example, lost her leg in a mine explosion, and the idea of leaving her two children alone helped her to recover from that shock. Emotional and cultural securities are crucial for resilience and should always be taken into account, even at a national level.

Risk management and adaptation are closely related to cultural heritage. Cultural heritage can provide signs that remind local society of the hazards they are exposed in their territories. For example, in Popayan, Colombia, there is an ancient cross that warns about the lighting risks in the region. Yet in 2015 twenty indigenous people died in a lightning event.

To finalise, Gustavo Wilches commented that current laws are not protecting the night landscape, generating significant light pollution. He invited the presenters to join the fight against light pollution as an energy-saving strategy.

Tools for risk management with respect to energy: Wendy Guerra, World Bank, Bolivia

Energy-generation installations and the personnel working in them are subject to a number of risks, both during the construction and the functioning

of energy installations and equipment. Risks may be the result of human error, accidents, and natural disasters. Energy investment projects in Bolivia are required by law to include a risk evaluation to ascertain that generation facilities are not constructed in risk prone areas, and to ensure that their design considers vulnerability and risk factors. The law also requires that costs for mitigation are established, which need to be included in the project's budget.

The World Bank has developed a tool to assess the risk index at the level of municipalities, establishing the level of threat from different disasters based on historical records. Threats and vulnerabilities are identified for all components (operative, social, economic and environmental) at the initial stage of the project, and the costs of prevention and mitigation measures against medium and high-level vulnerabilities are determined. The tool also assists in establishing the priority of each of the mitigation measures. The same procedure is carried out to determine the potential effects of climate change.

The World Bank has developed additional methodologies for incorporating risk management practices in the development of projects, which are available from their website. Additional tools include a participatory method to develop community risk maps based on historical data.

In conclusion, Wendy Guerra underlined the importance of implementing policies for managing risks to energy infrastructure (for the generation, storage, distribution, and use of energy) in smart villages. It is critical to develop resilience strategies to reduce the potential impact of disasters, such as improving knowledge of the risks and developing prevention, mitigation, and recovery actions. Strategies for dealing with the potential effects of climate change on the community also need to be determined.

Risk management: communities and the energy sector: Daniel Monroy, Government Secretary, Mexico

SINAPROC, Mexico's National Coordination for Civil Protection, was established in 1985 following an earthquake in the capital city which claimed the lives of between 10,000 and 20,000 people. This event highlighted the importance of establishing response systems to protect Mexican citizens from natural and anthropogenic disasters. SINAPROC's constituency includes all the federal, state, and municipal government agencies, civil society organisations, and all the residents of the country. Following the establishment of SINAPROC, Mexico changed its building regulations and school curricula to increase the country's resilience.

The legal framework for the current national development plan for civil protection (running from 2012 to 2018 as the term for the federal government) includes: the National Energy Strategy, with a Law for the use of renewable energies and financing for the transition in the energy sector; the National Strategy on Climate Change, which led to the passing of the General Law on Climate Change; the Law for Civil Protection, and the Energy Reform. The legal framework was designed to attract national and international investment, and this has facilitated the establishment of public-private partnerships (PPP) for projects addressing risk mitigation in the country. These strategies are transversal, bringing together all the government sectors of the country, including urban development, health, education, energy, communication and commercial activities. Priority is given to communities identified as particularly vulnerable, utilising a methodology that integrates risk and frequency of, and vulnerability to, extreme weather conditions and natural disasters. The analysis has indicated that Mexico has over 2,400 municipalities, of which about 1,380 are exposed

to climate vulnerabilities, representing 27 million people in the country; while 824 municipalities, representing 61 million people, are in areas with very high risk of inundations. These risks need to be addressed at the level of communities.

Mexico's population is expected to reach 121 million people by 2050, and developing housing to cope with demand is a national priority. A number of initiatives have been put in place to subsidise social housing and to reduce the environmental impact of new buildings, both by reducing consumption of energy and water, and by increasing the average lifespan of new housing. Lack of knowledge and of capacity at various levels (both in government institutions and in communities) and lack of financing are among the key challenges, as is the fact that programmes designed at a desk do not always match local needs. In addition, it is sometimes hard for communities to change their practices. Technical and institutional challenges, especially at the local level, are also important.

The 102040 Plan sets the vision that the country wants to achieve in a number of areas: society and population; ecosystems; energy; emissions; productive systems; private sector, and industry and transport. A challenge is that many development plans last only the presidential term.

Discussion session I

A large number of different definitions are currently being used in the field of mitigation of natural disasters, which can be problematic in global initiatives. In an effort to clarify the situation, the United Nations General Assembly, in the context of the Sendai Framework for Disaster Risk Reduction, is about to approve and publish a new glossary of terms on resilience and risk management.

The impact of the different energy technologies needs to be considered, not only from the anthropogenic point of view, but also in respect of their effects on other parts of the ecosystem. The status of other species, such as fish in aquatic systems, migratory birds, and the maintenance of urban species diversity, also provides an indication of the health of ecosystems (such as the quality of air and water), and whose loss also impacts on the quality of life of humans.

One example of the energy reform taking place in Mexico, where 2.7 million people in rural areas have no electricity, is a collaboration between a company, Enlight, and the social enterprise Ilumexico. They have a project in which for each solar installation in a city, a subsidy is provided for the installation of the same equipment in resource-poor households in rural areas with no connection to the grid. Public-private partnerships have the potential to improve access in remote locations with difficult access and dispersed populations, and can greatly increase impact since not all the funding needs to be provided by the government.

Mexico has also accumulated experience in dealing with national disasters; for example, the Federal Commission for Electricity is able to rapidly take down the grid cables before a hurricane is about strike to protect it, reinstalling them once the risk is over, which is the cheapest and most effective way of reducing damage to the infrastructure.

All types of electrical installations need to have risk assessment attached to them, and consideration should be given to the cultural acceptance of the technology by the community, as it can really influence whether it is successfully adopted.

One phenomenon that is becoming apparent is the movement of well-off people to rural areas in search of a better quality of life (e.g. air and water). The Sendai Framework is in fact applicable to both urban and rural locations. It is important to acknowledge that the resilience of urban areas is intimately related to their capacity to establish good links with rural areas, which are the ultimate

source of water, food and energy. This requires building relationships of reciprocity which also safeguard the quality of life in rural locations.

One example provided where this is not the case at the moment is the situation in Colombia, where the populations of the rural area that provide water for Bogota themselves lack access to this resource. Sustainability requires that rural communities providing water services to the capital should also have a good quality of life and adequate services. The latest technological advances allow rural access to services and provisions that were previously exclusive to urban centres, so access to these services should not require relinquishing a rural lifestyle. Water access for urban areas, which is closely linked with land issues and indigenous rights, is also a key issue in Bolivia. Another manifestation of the symbiosis between rural and urban areas is the movement of people between them, depending on where there are better opportunities at a specific time.

A joint initiative between CELAC (Comunidad de Estados Latinoamericanos y Caribeños) and the United Nations' Food and Agriculture Organisation (FAO) has developed a policy for risk management and mitigation for rural areas engaged in agricultural production. The aim was to safeguard the continent's food and nutrition security. The unsustainable use of resources is also a threat to rural areas, which underlines the fact that the problem is sectorial with many different facets and components. In addition to the agricultural sector, the energy sector is critical for risk mitigation, and currently there is an effort to define minimum standards to ensure the resilience of the relevant infrastructures. Critical for an effective risk management strategy is to achieve an integrated approach across all sectors, which is still not a reality.

Session II

Little explored aspects of resilience to disasters in the energy sector: Marco Antonio Rodríguez, World Bank, Bolivia

During the last hurricane in the Caribbean, Haiti was considerably affected. The international press followed closely the recovery progress of the country, but little attention was given to the effects of the hurricane on the rest of the Caribbean islands. For example, there was scarce information about the fact that the Bahamas spent nearly one month without electricity. Actually, the most affected sectors after a natural disaster are the electrical and distribution systems of nations. In this particular case, the Caribbean islands were strongly affected by the lack of electricity since they are extremely dependent on tourism for livelihoods. Moreover, post-disaster evaluations do not always show the entire picture of disasters and often underestimate damage.

The term 'resilience' refers mainly to the capacity for recovery from disasters of people and the ecological and infrastructural systems on which they depend. Communities, for instance, are social systems at every scale; for example, households, schools, villages, and cities. So systems can have sub-systems inside them and resilience is not cumulative along them. For example, some small villages can be very resilient to the impact of an earthquake, but that does not mean that the whole country will be resilient to that type of shock. Hence it is not possible to refer to resilience in communities without referring to municipal, regional, and national resilience. If a system is not balanced, the interrelationship between all the sub-systems has to be evaluated to build resilience. A good example of a resilient living being is the tardigrade, which can survive extreme conditions that would be fatal to nearly all other known life forms.

Resilience can be considered in a sequence of phases. Initially, systems are in a "normal" state. When the system is shocked by a natural disaster, it moves to the second phase, in which it is stressed and deformed. At this moment, the concept of resilience is activated to absorb the energy from the shock and then release it in order to return to its original form or to adapt to a new form. The final stage is assimilation of the shock. Here the idea is to increase communication within the system to create synergy for possible shocks in the future.

Marco Antonio Rodríguez ended his presentation by stating the need to clearly define the meaning and boundaries of the resilience concept, as well as how resilience differs from the concept of vulnerability. To speak about resilience further aspects should be explored, which include:

- What is the understanding and knowledge about the natural disaster risks at a community level, and how they link to a municipal, regional, and national level?
- Is decreasing vulnerability the same as increasing resilience?
- How can we increase and promote resource use of a community efficiently?
- Is poverty related to the lack of resilience? To what extent does development generate better opportunities?
- How can financial resources be improved? And how can the protection of finances from natural disasters be promoted as part of the resilience agenda?
- What would be the effect of the anti-globalisation movement?

Emergency management experiences in communities focused on energy:
Miguel Kurita and Ofelia Insaurralde, National Emergency Secretary of Paraguay

The National Emergency Secretary of Paraguay is a governing body that aims to manage and reduce the risk of disasters in Paraguay. Their role is to promote the execution of Risk Reduction and Management policies and to provide a platform that promotes dialogue in these matters between different sectors of the country and society.

During the last 20 years, Paraguay has been subjected to several anthropogenic, epidemic and hydro-meteorological events. However, within the last two years the country has experienced persistent storms and floods due to the El Niño phenomenon. The consequent emergencies have impacted people all over the territory, with 920,900 people assisted in 2014, 1,051,660 people in 2015, and 984,465 people in 2016. In 2013, Paraguay was ranked sixth place in Latin America and the Caribbean on the number of small and medium-sized disasters, and it was ranked second place on the destroyed housing rates for every 100,000 inhabitants as a result of recurrent river overflows.

In the last 40 years, Paraguay has increased its electricity generation six-fold. This consistent growth has been possible due to the development of the distribution infrastructure and the construction of two large-scale hydroelectric plants (Itaipú and Yacyretá dams). Since the late 1990s, Paraguay has increased its electricity coverage from 48% to 96.7%, missing only some isolated regions of the Paraguayan Chaco. Despite the fact that the government subsidises up to 75% of the energy costs of monophasic installations if the user does not exceed a certain consumption, the electricity distribution company , La ANDE, estimated in 2013 losses of around US$22 million due to energy theft (around 6%). The use of renewable energy has barely begun and the country is still relying on biomass for cooking which accounts for 46% of its energy consumption. Currently, the emergency management arrangements are weakly associated with the energy sector, but the National Emergency Secretary is working hard to change this situation and improve the relationship between both bodies.

The National Emergency Secretary is now working closely with La ANDE in post-disaster recovery. They organise local worktables to contribute to people's security after disasters by providing information and support about the risks that people are exposed to. In the floods of 2015, for example, the government ordered households to switch off the electricity supply to their houses, but eight people died of electrocution as they had not implemented this instruction. Therefore, the organisation aims to avoid these types of regrettable events.

Another initiative that the Emergency Secretary has been developing is the construction of a pilot neighbourhood with potable water and waste management systems for families temporarily displaced by disasters. Nevertheless, people have been reluctant to leave their homes and make use of these facilities. Moreover, the Secretary controls five pre-positioned centres distributed across the country. They contain the main supplies that are commonly necessary in a state of emergency.

Community resilience in the energy sector: planning experiences and construction of human settlements:
Ricardo Canevari, Independent Consultant, Argentina.

Ricardo Canevari talked about his experience in the post-war recovery of Central America. In this particular situation, communities have had to assume the responsibility for creating their own resilience plans and to look after their own future. When the civil war was over, all the families that had moved because of the war returned to their villages. This phenomenon included the reincorporation of guerrillas, reconciliation between

villages, and the repair of physical damage of towns. In Nicaragua and Guatemala, this situation generated a natural process of self-reconstruction, where men, women, and children worked together in an equal distribution of responsibility to construct their houses and neighbourhood. The process created unique social ties among the people living in the communities, and a personalised framework of resilience was born with it.

In the following years, Central America was stricken by the hurricanes Mitch (1998) and Stan (2005) that resulted in major devastation in the region. Ricardo Canevari cited the definition "the risk to natural disasters is the result of historic processes characterised by the inadequate use, occupation and transformation of the territory". This extract means that people live where they can, not where they want. Therefore, the post-war reinsertion process gave people the required tools to face disasters and after the hurricanes they started the self-construction process again.

The community of Cruz Laguna, located on the banks of the Coco River in Nicaragua, was an emblematic case in terms of resilience. After hurricane Mitch, residents of the community met together to develop a recovery plan. The fact that they could organise themselves and assume the challenge of being able to get by on their own, without the guidance of a governing body, created a notion of ownership and independence in the community. The attitude of Nicaraguans in the face of disasters was outstanding and, in less than a year, Nicaragua had largely rebuilt after the damage caused by the hurricanes. This might imply that the recovery experience gained by the Nicaraguans after the war made them resilient to any other type of shock.

In order to create a new human settlement plan the Nicaraguan Institute of Territorial Studies worked in collaboration with the National University of Engineering on the identification of safe areas to establish new housing projects. In this study, the opinion and experience of the community was taken into account. The role of the community leaders was fundamental, likewise the participation of women. For example, in the volcanic lake of the San Marcos Department, Guatemala, there were several communities living on the slopes of the volcano. Only one of those villages had organised senior leaders who took the decision to abandon the village due to visible risks of a mudslide from the lake. The people of that community were the only survivors of the mudslide that hit the area two days later. To conclude, Ricardo Canevari emphasised that without the approval and collaboration of the community it is challenging to achieve successful residential projects in rural Central America.

Experiences of risk management for communities and energy access in Costa Rica: Emilia Jimenez, Municipality of Santa Ana, Costa Rica.

Emilia Jiménez talked about her work on risk management for the municipality of Santa Ana. In 2010, a devastating mudslide travelled along the Chitaría hill located in the Salitral District of Santa Ana. Similarly, due to the geographic and hydrologic nature of the region, El Cantón of Santa Ana has to be in constant reparation in order to avoid new landslides. This permanent threat has encouraged the Municipality to dedicate significant resources to disaster risk management. Currently, the municipality of Santa Ana has a network of early warning systems with three sirens, and two emergency committees and two civic associations formed by local people that are continuously discussing and evaluating methods to mitigate risks.

The strategy to mitigate risks comprises environmental management with recuperation and caring plans for ecosystems; a territorial ordering plan for land use and families settlement; the strengthening of livelihoods through risk management support; and governance arrangements at a national and subnational level that focus on educating society about disaster risk management.

In 2016, the northern part of Santa Ana was hit by hurricane Otto, one of the strongest hurricanes of the region's history. The storm took the life of 9 people and caused important infrastructure losses. But at the same time, the event helped to create a new system of shelters, outline an emergency protocol for hurricanes, a technical form to evaluate post-disaster damages, and a new tool to monitor disasters. GEOMATICA, for example, is performing studies to measure landslide threats, so the Municipality can respond by stabilising the land in areas of risk. Additionally, the municipality executes educational programmes about risk management for schools, and performs regular maintenance of roads and evacuation routes. The total investment of the Municipality in disaster risk management is close to US$250,000.

The effect of climate change on community resilience: Rodrigo Cisneros, Independent Consultant, Bolivia

Rodrigo Cisneros focused his presentation on technologies and techniques that could be applied in Latin America to increase resilience to climate change in rural communities. His presentation started with an overview of the meaning of energy and an explanation of the different energy forms existing in the world. Participants were reminded of the differences between renewable and non-renewable energies, the basic concepts of energy physics such as Einstein's mass-energy equivalence formula, and Newton's laws of classical mechanics. He stated that our concept of renewable energy resources corresponds to solar, wind, geothermal, nuclear, and hydro, whereas non-renewable resources are represented by fossil fuels. The presentation evaluated the role that every energy resource plays in the resilience of rural communities.

Nowadays, wind turbines have evolved into efficient structures that are capable of transforming large amounts of kinetic energy into electricity. However, people tend to forget that wind technologies existed for centuries in Europe with the traditional windmill system. Windmills were used to pump water or grind grain, and they worked exceptionally well for centuries. Although this technology had a vast trajectory in the old world, in Latin America they were hardly employed. Another example that caught the attention of experts was the ancient windmills of Nashtifan. They consisted of horizontal windmills with a long vertical driveshaft and six to twelve rectangular sails, and they were used at home as well as in the grist milling and sugarcane industries. These examples show simple designs that have proven their efficacy for ages; furthermore they support the fact that wind energy is a resilient technology to climate change since wind resources are not expected to change with the global warming phenomenon. Nonetheless, developers in Latin America insist on implementing new systems instead of evaluating the application of traditional technologies.

Hydro energy is found in the form of large dams, run-of-river facilities, and watermills. Run-of-river hydropower channels flowing water from a river through a canal or penstock to spin a turbine and then returns the water back to the river. It is a system that requires little infrastructure and is fairly simple to build if the geographic characteristics are appropriate. The slopes and valleys of the Andean region in South America are ideal terrains for the application of this technology, but besides a few examples in Argentina and Chile, run-of-river plants are hardly found in the rest of the region. Likewise, watermills are traditional systems that have been used in some places in Africa to generate small amounts of electricity. Hydropower technologies are easily replicable but have the disadvantage that water resources will be substantially affected by climate change. Even today there are several dams that are completely dry with limited possibilities of recovery, such as the large dam of Misicuni in Bolivia, for example.

Solar energy should not be affected by climate change; it might be possible that patterns of cloudiness will be altered in some places, but the re-

source will be always available. Nuclear power is the most resilient technology to generate electricity. Although it leaves behind radioactive residues that are more complex to treat, it is considered impervious to climate change. Lastly, thermal plants are in theory resilient to climate change but at the same time are the primary contributors to the phenomenon, therefore are not suggested as a solution in this case.

With regards to water resilience, the "takanas", or agricultural terraces, are an ancient technique used by the Inca civilisation that consisted of carving the hill's slopes into a series of receding terraces for the purpose of more effective farming. Takanas are extremely resilient and have the ability to save water, avoid erosion and retain humidity and water flows in mountainous terrains. Currently, they are not used due to the fact that Spanish colonisers imposed their own crop practices and forced natives to adopt them. This is an excellent example of when the introduction of new methods is assumed to generate progress for communities when in fact it results in the opposite. A similar method with great potential in Latin America is the Suka Kollus terrace used, even today, in China.

There are also resilient techniques to store water that consist of pumping water to storage tanks using hydro or solar power. The benefit is that they do not rely on the grid, so they will continue working in the absence of an electricity supply due to disasters or any other event. Similarly, adobe houses with heavy roofs are much more resilient to earthquakes than many other construction styles, so why are they not taken into consideration nowadays?

Rodrigo Cisneros concluded his presentation by stating that all these traditional technologies were incredibly ingenious and resilient, but the evolution of society has forgotten them and their benefits to solve several problems present nowadays. The recovery and reutilisation of these technologies is a challenge for innovation in the developed world.

Relationship between resilience, territory and the environment: Alexander Coles, Florida State University, Panama

Human intervention in natural habitats has had negative direct and indirect implications for their ecology and species compositions, generating risks and sometimes leading to cumulative threats. Resilience is also a characteristic intrinsic to ecosystems and to human populations, which manifests itself following a perturbation. It can be considered as the adaptive dynamic that allows communities to respond and adapt to change and to distress.

Formulating policies for the management and mitigation of risks for both ecological systems and human communities is therefore a development imperative. There are many strategies for managing risks in rural populations. Connecting with communities is critical to increase their resilience to natural disasters and their ability to cope and recover from them, as is acknowledging and respecting cultural beliefs and customs. Failure to do this often results in recommendations being rejected. Open dialogue, on the other hand, can help communities realise the importance of specific risk management measures for improving their livelihoods.

Changing land use patterns, such as the expansion of urban populations into former agricultural land, is affecting rural communities and their livelihood options.

Discussion session II

Participants at the workshop were encouraged to expose themes related to risk management and energy access that they could not fully consider during their presentations.

The first contribution reflected that while many methodologies and initiatives exist to increase the resilience of the continent, the poverty of many communities remains a key problem. People tend to return to build their homes in risk-prone areas simply because they lack alternatives: you live where you can, not where you would like to. In situations of poverty short-term needs, like finding enough to eat, take precedence over medium- and long-term considerations of safety.

Disasters undeniably have a negative influence on communities, but they can also strengthen social links and channel resources in a better way, thereby generating positive economic gains and possibly increasing resilience to future disasters. It is important not only to assess the cost of increasing the resilience of specific infrastructures, but also to determine when these investments should be made, as reconstruction may be a better option in certain circumstances.

In terms of methodologies for mitigating climate change, one fundamental problem is that the effects, especially in the medium and long term, are not well known. One approach, followed by Princeton University, is to analyse possible scenarios in three dimensions, which also considers the level of resilience of different options and establishes the economic cost of improving it.

The World Bank has recently carried out a study on the effectiveness of investments to reduce risks, and there is a new parameter which is to determine to what extent interventions have reduced the vulnerability of the poorest parts of the populations. This is very important, since this study estimated that approximately 26 million people fall back into poverty due to disasters every year.

Another important theme to consider is the cross-cutting nature of risk mitigation in terms of climate change. While climate change mitigation will attract increasing resources, what is lacking is an overall vision on what should be done to deal with the problem. The limits of different options also need to be established. For example, it is estimated that the cost of road construction would increase by 20 to 30% if they were built to withstand the effects of climate change. Increases in investments need not be the only response to climate change; often, increasing the quality of infrastructure would represent a more appropriate response. However, for many of the questions open now in the field of risk mitigation there are no clear answers.

A fundamental step in terms of adapting to climate change is to adapt to the increased variability of climatic conditions. An example in Colombia is provided by areas that were one year affected by severe droughts due to El Niño, and were struck by inundations the following year due to la Niña. While many investments were made in the area, these did not improve the resilience of the affected communities.

One community response in Colombia following the destruction of housing by natural disasters was the collective rebuilding of houses by community members. One of the positive outcomes is the process of reconstruction itself, which results in the strengthening of social bonds and in the increase of capacity and resilience in the community. Government initiatives to develop free housing in this context may therefore be counterproductive, and potentially increase the vulnerability of communities. While these initiatives may initially provide a source of income to kick start the economy, often when the intervention ends the benefits are not sustainable. Another way of assisting communities in post-disaster situations is for governments to pay a salary for their members to contribute to rebuilding efforts. This helps the rehabilitation of the community's economy.

In terms of interventions for risk management and mitigation, and for improving the resilience of communities through energy access, the most successful approach in Mexico involves public-private partnerships to develop community projects, for example focused on productive uses. Associations

between government and the private sector, civil societies, and the communities are essential to oversee the projects and ensure they deliver the expected results and do not remain at the pilot stage. It is very hard for governments to supervise unilateral projects in communities, which are also more vulnerable to failure because of corruption.

A common occurrence in the region is that there are big differences in access to resources, such as water, in different parts of the country. What is needed is to develop and apply an ethical framework to ensure that the overall benefits of developing infrastructure projects that require the displacement of communities are also shared among the people negatively affected.

There are two points of intervention: before an event (prevention) and after an event (recovery). SDG7 on universal energy access is key for prevention, and different available technologies for energy access should be analysed, also from a risk mitigation perspective, to determine which are the most appropriate for a given community. Similarly, in a post-disaster situation, damaged energy infrastructures should be replaced with new systems following the same criteria, rather than simply going back to what was in place before. Indigenous communities should be the focus of development initiatives, since they are very often among the most vulnerable.

Access to energy has sometimes been described as a factor that increases the vulnerability of communities to natural disasters, since they will find it harder to cope with the loss of energy access during post-disaster situations than communities who never had it. Energy access creates a form of dependency. This is however a negative view of energy access. Smaller, decentralised energy systems are more flexible and easier to repair and reinstall after a disaster, and they reduce dependency on the grid system. These "smart solutions" are especially important in remote areas with dispersed communities, which typically are the last to receive government assistance post disaster since priority is given to densely populated areas. It is also important to remember the close link between energy access and poverty, which in turns increases vulnerability to disasters. A critical challenge is to determine how information and technical know-how translate into effective policies and interventions.

Another key problem in many countries in the continent is the lack of long-term investments and solutions for risk management and mitigation. This is a critical society challenge, linked to our current political systems.

A critical challenge in Paraguay is to determine how communities should be motivated to adopt measures for risk mitigation and participate actively in the management of risks. In Paraguay, many populations emigrating from the countryside to urban areas have settled in areas prone to inundations, also with initial assistance from the government which provided minimal services (water, health service and education facilities). In terms of energy, electricity is usually obtained by settlers illegally by connecting to the lines, risking their lives. Once the communities are settled it has proved very hard to rectify the situation, despite periodic inundations and government incentives for relocation. In terms of providing energy access to rural indigenous communities, the most vulnerable in the country, there is a need to both understand important cultural factors for the acceptance of new technologies, but also ensure that adoption is sustainable, in particular with respect to the ease of maintenance of equipment.

A further problem is that development projects targeting rural communities are often designed by urban professionals, with expectations that on occasions cannot be met. The sustainability of projects is frequently related to the existence of an expressed demand by the communities for a particular service. Isolated energy solutions are a very good solution for isolated rural communities, but should perhaps not be considered as the final solution, since most people expect to

be grid-connected at some time. Increasing the resilience of rural populations is very important because of the fundamental inequity and injustice between urban and rural centres.

The importance of establishing country funds for dealing with emergencies was underlined. While international funds may be accessed by a country after a disaster, these funds are loans which need to be paid back, and one of the reasons why Caribbean countries have very high debts is because reconstruction is carried out with international financing.

John Holmes closing remarks

John Holmes thanked participants for their valuable contributions to the workshop. He explained that the proceedings would be published as a workshop report, and that key conclusions and recommendations would be published as a brief for policy makers. He encouraged participants to disseminate the reports to their networks of contacts. Resilience is a key issue for rural communities, and an issue that the Smart Villages Initiative will continue to address in its future activities.

Annex 1: Workshop Programme

"Sustainable energy resources for risk management and resilience of communities in Latin America and the Caribbean"

30 January 2017,

Hotel Marriott, Quito, Ecuador

09:00 Welcome and workshop presentation

John Holmes, Smart Villages

Ricardo Peña Herrera, GDRD Secretary

09:15 The Smart Villages Initiative

Claudia Canales and John Holmes, Smart Villages, United Kingdom

09.40 Resilience experiences in Ecuador and the relationship with the energy sector

Ricardo Peña, Secretary of Risk Management, Ecuador

10:00 Resilience as State Policy

Ricardo Mena, United Nations Office for Disaster Risk Reduction (UNISDR), Ecuador

10:20 Feed many birds with the same guava

Gustavo Wilches, Externado of Colombia Universit,; Colombia

10:40 Coffee break

11:00 Tools for risk management with respect to energy

Wendy Guerra, World Bank, Bolivia

11:20 Risk management: communities and the energy sector

Daniel Monroy, Government Secretary, Mexico

11:40 **Discussion session I**

13:00 Lunch

14:00	Little-explored aspects of resilience to disasters in the energy sector *Marco Antonio Rodríguez, World Bank, Bolivia*
14:20	Emergency management experiences in communities focused on energy *Miguel Kurita and Ofelia Insaurralde, National Emergency Secretary of Paraguay*
14:40	Community resilience in the energy sector: planning experiences and construction of human settlements *Ricardo Canevari, Independent Consultant, Argentina*
15:00	Experiences of risk management for communities and energy access in Costa Rica *Emilia Jimenez, Municipality of Santa Ana, Costa Rica.*
15:20	The effect of climate change on community resilience *Rodrigo Cisneros, Independent Consultant, Bolivia*
15:40	Relationship between resilience, territory, and the environment *Alexander Coles, Florida State University, Panama*
16:00	Coffee break
16:15	**Discussion session II**
17:45	Closing of the workshop

Annex 2: Participants List

Title	Name	Surname	Organisation	Position	Country
Dr.	Claudia	Canales	Smart Villages	Project Manager	UK
Mr.	Ricardo	Canevari	Independent Consultant	Consultant	Argentina
Ing.	Rodrigo	Cisneros	Independent Consultant	Institutional Development Specialist	Bolivia
Dr.	Alexander	Coles	Florida State University	Lecturer	Panama
Mrs.	Wendy	Guerra	World Bank	Consultant	Bolivia
Dr.	John	Holmes	Smart Villages	Project Co-Leader	UK
Mrs.	Ofelia	Insaurralde	National Emergency Secretary	Director of Planning and Systematization	Paraguay
Ing.	Emilia	Jimenez	Municipality of Santa Ana	Civil Engineer	Costa Rica
Ing.	Miguel	Kurita	National Emergency Secretary	Chief of Staff	Paraguay
Mr.	Daniel	Monroy	Government Secretary	Director of Innovation, Planning & Continuity of Operations	Mexico
Mrs.	Roberta	Mutschler	Smart Villages	Research Associate	UK
Mr.	Ricardo	Peña	Secretary of Risk Management	Sub secretary of Risk Analysis	Ecuador
Mr.	Marco Antonio	Rodríguez	World Bank	Consultant	Bolivia
Mr.	Gustavo	Wilches	Externado of Colombia University	Lecturer	Colombia

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New thinking for off-grid communities worldwide

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