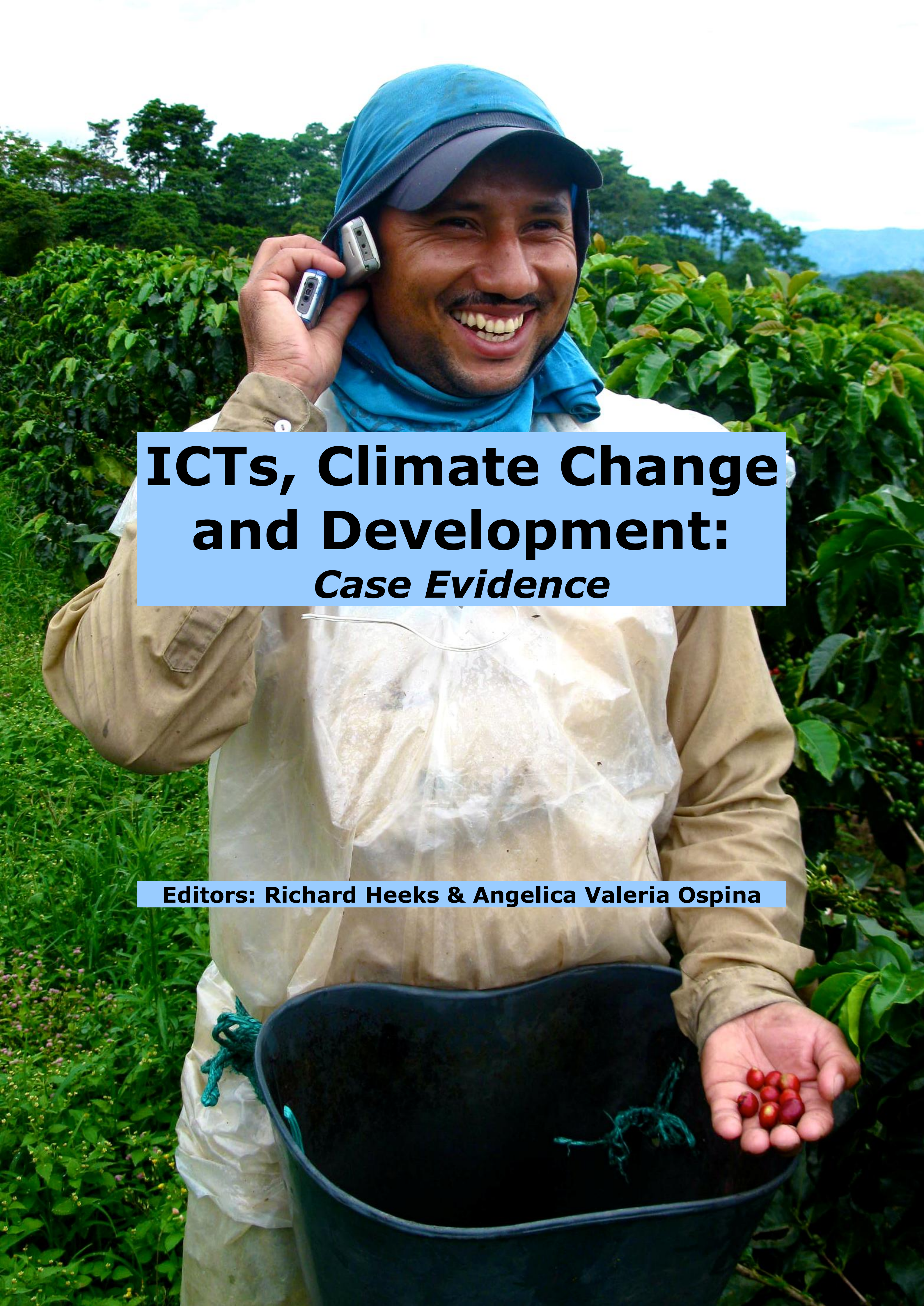

ICTs, Climate Change and Development:

Case Evidence

Editors: Richard Heeks & Angelica Valeria Ospina

ICTs, Climate Change and Development:
Case Evidence

Richard Heeks & Angelica Valeria Ospina (eds)

2012

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IDRC CRDI

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Cover photo credit: Angelica Valeria Ospina

Introduction and Overview

This is a complementary volume to the book "ICTs, Climate Change and Development: Themes and Strategic Actions", which reviews current evidence on this topic and offers strategic recommendations for policy, practice and future research. In this book, we present a set of twenty new case studies which were commissioned by the IDRC-funded research project, "Climate Change, Innovation and ICTs".

These case studies were commissioned following an open call for proposals, and were then professionally edited in order to provide materials that are suitable for use in:

- Practitioner/Strategy Guidance
- Training Materials
- Research

The cases are published under a Creative Commons licence that allows their re-use for non-profit purposes subject to attribution of the original source. They can be found online at: http://www.niccd.org/casestudies.htm

Each of the case studies follows a consistent format that includes:

- The nature of the ICT application
- The climate change-related drivers and objectives behind the case
- The main case stakeholders
- An evaluation of cost/benefit and success/failure
- Analysis of key enablers and challenges
- A summary set of lessons learned and recommendations

This book is organised into six parts, which broadly correspond to different elements of the overview ICCD model, shown in Figure 1.

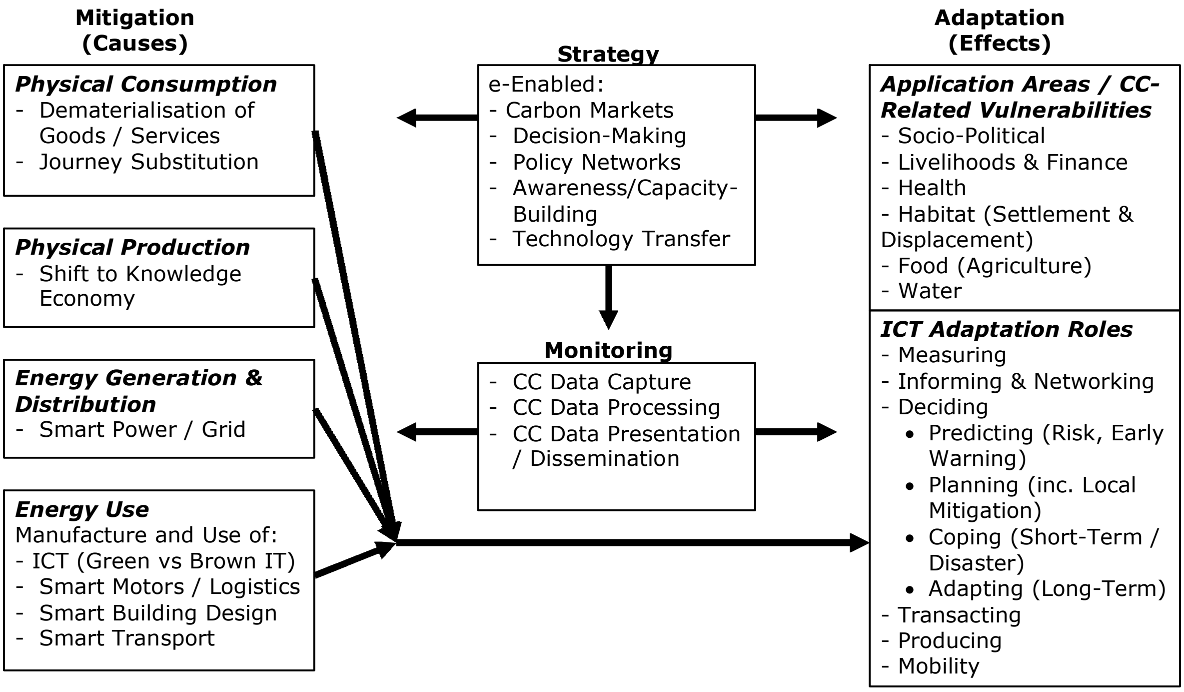


Figure 1: Overview Model on ICTs, Climate Change and Development (ICCD)

Table 1 summarises each of the case studies in the Parts and order in which they appear later in the book. Table 2 categorises the cases according to geographical region.

Topic Area	**Case Studies**
A. ***ICTs, Climate Change and Disaster Management***	A1. **Pakreport: Crowdsourcing for Multipurpose and Multicategory Climate-Related Disaster Reporting** investigates use of Ushahidi software for crowdsourced, SMS-based reporting from the ground during climate-related disasters, taking the case of recent floods in Pakistan. A2. **Role of ICTs in Early Warning of Climate-Related Disasters: A Sri Lankan Case Study** describes a multi-modal, mobile-based early warning system implemented in Sri Lanka. A3. **Using Mobile Phones to Reduce the Adversities of Climate Change in Rural Nepal** analyses a multi-purpose mobile phone initiative for farmers that incorporates agricultural and early warning information systems.
B. ***New ICT Routes to Climate Change Adaptation***	B1. **Participatory Video for Monitoring and Evaluation of Community-Based Adaptation to Climate Change** investigates the use of participatory video to help monitor, evaluate and learn from a series of community adaptation initiatives across Africa. B2. **ICT-Enabled Knowledge Sharing in North-South Partnerships: Lessons from the AfricaAdapt Network** analyses the experience of building a large network across Africa that has created and shared knowledge about climate change adaptation.

Topic Area	Case Studies
C. ***ICTs and Agricultural Adaptation to Climate Change***	C1. **e-Arik: Using ICTs to Facilitate "Climate-Smart Agriculture" among Tribal Farmers of North-East India** analyses use of Internet connectivity to encourage adoption of new farming practices that are more climate-resilient. C2. **An ICT-Based Community Plant Clinic for Climate-Resilient Agricultural Practices in Bangladesh** investigates the application of a broad range of ICTs including mobiles and digital cameras and microscopes to address problems of increasing salinity for rice farmers. C3. **Using Radio to Improve Local Responses to Climate Variability: The Case of Alpaca Farmers in the Peruvian Andes** describes a radio project for mountain farmers which helped them adapt to changes in temperature and rainfall patterns within a context of extreme poverty. C4. **ICT-Enabled Knowledge Brokering for Farmers in Coastal Areas of Bangladesh** evaluates the activities of ICT-using village "infomediaries" who support farmers near the Bay of Bengal facing rising sea levels and increased cyclone activity. C5. **e-Adaptation within Agricultural Livelihoods in Colombia's High Mountain Regions** documents the combined use of community radio and the Internet to build awareness and capacity around climate change in mountain agriculture.
D. ***ICTs and Climate Change Mitigation***	D1. **Combining Local Radio and Mobile Phones to Promote Climate Stewardship** summarises a project that linked SMS messaging and community radio to address deforestation and use of wood-fuelled cookstoves in Southern Africa. D2. **Reducing Carbon Emissions through Videoconferencing: An Indian Case Study** provides financial and carbon cost/benefit analysis of videoconferencing within an Indian state government, and draws out lessons for future practice. D3. **Mitigating ICT-Related Carbon Emissions: Using Renewable Energy to Power Base Stations in Africa's Mobile Telecommunications Sector** investigates the use of solar and other renewable energy sources to power the growing number of off-grid base stations being used to support mobile telephony in Africa.

Topic Area	Case Studies
E. ***ICTs and Climate Change Monitoring***	E1. **ICT-Based Monitoring of Climate Change-Related Deforestation: The Case of INPE in the Brazilian Amazon** analyses a remote sensing/GIS-based system that provides data for rangers, scientists and others, and that enables deforestation to be monitored and reduced. E2. **Improving Access to Mapping, Modelling and Scenario-Building Technology in Climate-Vulnerable Regions: Learning from ClimSAT** describes an international partnership that sought to build ICT and informational capacity within regional governments, in order to improve their ability to monitor and plan for climate change. E3. **Learning from Egypt's Environmental Monitoring and Reporting Systems** investigates Egypt's attempts to build and integrate high-level environmental information systems, for strategic planning and in order to provide country reports as required by the UNFCCC.
F. ***ICTs and Climate Change Strategy***	F1. **Using ICTs to Integrate Frontline Views into Strategic Planning for Climate Change** analyses the use of web- and mobile-based channels to bring frontline views from 69 countries into global debates on disaster risk reduction. F2. **Supporting Strategic Decision-Making on Climate Change Through Environmental Information Systems: The Case of ENVIS** reviews a national environmental information network created in India, learning lessons from both its achievements and shortcomings. F3. **Building the Evidence Base for Strategic Action on Climate Change: Mexico City's Virtual Climate Change Centre** describes a multi-stakeholder initiative that sought to build city-wide climate change information in Mexico. F4. **PRECIS: Regional Climate Modelling for Adaptation and Development Planning** investigates roll-out of UK-origin climate modelling software to developing countries, providing the basis for many scientific and policy documents.

Table 1: Categorisation and Summary of Case Studies by ICCD Domain

Categorisation by Region	**Case Studies**
Africa	Egypt: Learning from Egypt's Environmental Monitoring and Reporting Systems Zambia: Combining Local Radio and Mobile Phones to Promote Climate Stewardship
Latin America	Brazil: ICT-Based Monitoring of Climate Change-Related Deforestation: The Case of INPE in the Brazilian Amazon Colombia: e-Adaptation within Agricultural Livelihoods in Colombia's High Mountain Regions Mexico: Building the Evidence Base for Strategic Action on Climate Change: Mexico City's Virtual Climate Change Centre Peru: Using Radio to Improve Local Responses to Climate Variability: The Case of Alpaca Farmers in the Peruvian Andes
South Asia	Bangladesh: An ICT-Based Community Plant Clinic for Climate-Resilient Agricultural Practices in Bangladesh Bangladesh: ICT-Enabled Knowledge Brokering for Farmers in Coastal Areas of Bangladesh India: e-Arik: Using ICTs to Facilitate "Climate-Smart Agriculture" among Tribal Farmers of North-East India India: Reducing Carbon Emissions through Videoconferencing: An Indian Case Study India: Supporting Strategic Decision-Making on Climate Change Through Environmental Information Systems: The Case of ENVIS Nepal: Using Mobile Phones to Reduce the Adversities of Climate Change in Rural Nepal Pakistan: Pakreport: Crowdsourcing for Multipurpose and Multicategory Climate-Related Disaster Reporting Sri Lanka: Role of ICTs in Early Warning of Climate-Related Disasters: A Sri Lankan Case Study

Categorisation by Region	Case Studies
Multi-Country	Africa: Mitigating ICT-Related Carbon Emissions: Using Renewable Energy to Power Base Stations in Africa's Mobile Telecommunications Sector Africa/UK: ICT-Enabled Knowledge Sharing in North-South Partnerships: Lessons from the AfricaAdapt Network Global: Improving Access to Mapping, Modelling and Scenario-Building Technology in Climate-Vulnerable Regions: Learning from ClimSAT Global: Using ICTs to Integrate Frontline Views into Strategic Planning for Climate Change Global South/UK: PRECIS: Regional Climate Modelling for Adaptation and Development Planning Southern/Eastern Africa: Participatory Video for Monitoring and Evaluation of Community-Based Adaptation to Climate Change

Table 2: Categorisation and Summary of Case Studies by Geographical Region

Part A: Case Studies of *ICTs, Climate Change and Disaster Management*

A1. Pakreport: Crowdsourcing for Multipurpose and Multicategory Climate-related Disaster Reporting

Authors: Faisal Chohan, Vaughn Hester, and Robert Munro

Initiative Overview

Fierce monsoon rains in 2010 caused the worst flooding in Pakistan in 80 years (Aon Benfield 2010). Approximately one-fifth of Pakistan's total area was underwater at the height of floods. The floods displaced and affected 20 million people, mostly via destruction of property, livelihood and infrastructure. Close to 2,000 people died as a result. Although the specific link to climate change is unclear, it is generally agreed that climate change is already increasing the risk of flooding and that this risk will grow in future (IPCC 2007). In particular, "Pakistan stands among the group of developing countries which are extremely vulnerable to the adverse impacts of climate change." (Planning Commission 2010:13). In recent years, climate change in Pakistan is evidenced by an increase in temperature in summer and timing changes of the monsoon season (Dell'Amore 2010). These changes are affecting agricultural patterns, but they also threaten a greater incidence and intensity of natural disasters, including floods.

During such disasters, information is at a premium: there is an urgent need to know which areas are affected; how they are affected; what the priority problems are; and so forth. This typically coincides with the disruption of traditional lines of communication. The advent of mobile phones has provided a new digital development infrastructure, which may be of significant value to disaster response. Pakistan has seen particularly strong growth in mobiles, with roughly 110m subscriptions in mid-2011; well in excess of the adult population (PTA 2011).

This case study focuses on Pakreport, an ICT initiative between crisis mapping organisations, engineers, relief agencies and crowdsourcing companies that began in July 2010 as a response to the floods. We will review emergency communication using ICT tools and volunteers using crowdsourcing platforms to perform verification, categorisation, translation, and mapping of the information in real time. This initiative demonstrates ICTs' impact on climate change in the domains of both adaptation (disaster management) and monitoring (Heeks 2009). This case study will extend previous research on crowdsourced workflows for crisis relief in Kenya and Haiti.

Application Description

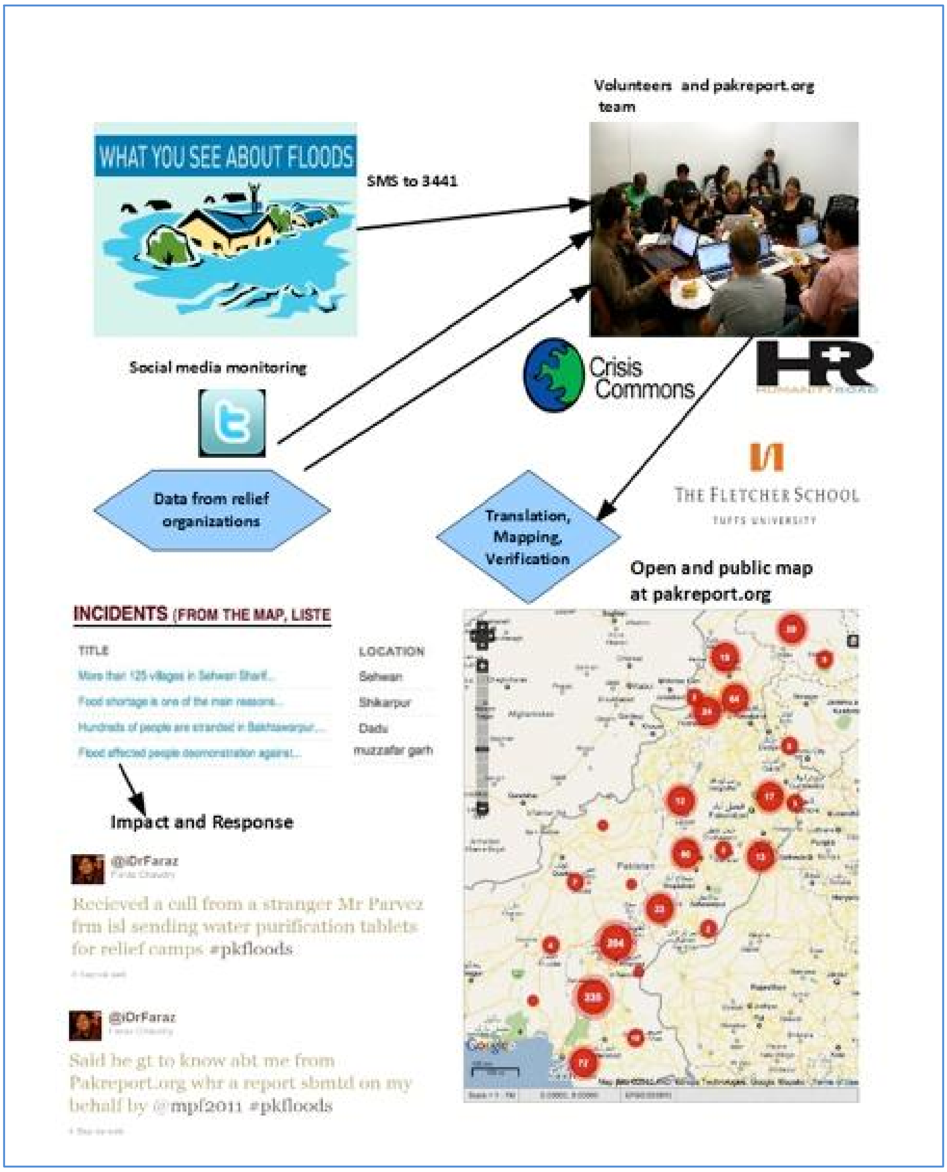
Pakreport is a customisation of Ushahidi[1] software in Pakistan which employs two forms of crowdsourcing. First, the use of a distributed group of people to provide data reports from the ground. Second, the use of a (very different) distributed group to translate, categorise and geolocate the incoming messages; this being undertaken via a CrowdFlower microtask[2]. Once the information was processed, it was input and displayed on the Pakreport.org platform; most visibly via an online map: see Figure 1.

[1] Ushahidi is an open source application which allows users to collect crisis information from large numbers of people.
[2] CrowdFlower is a company that crowdsources projects by breaking them into microtasks: a microtask is another name for a short, online form that can be completed by a member of the crowd performing a small analytical task.

The Pakreport platform was deployed on 8th August 2010, and could accept data input in many different forms: via radio channels, via social media sites such as twitter, and directly online via the web site itself. However, the primary source of initial information was a set of village-level assessments direct from the relief agencies which detailed the situation and damage on the ground. These reports were categorised and mapped via Pakreport staff.

The team also wanted a simple way for ordinary people caught up in the disaster to report their situation. SMS was seen as the most effective means for this, and the team at Pakreport set up a short code – 3441 – that was available on four of the five mobile companies in Pakistan. It was a shared short code, so the "FL" tag needed to be appended before the message.

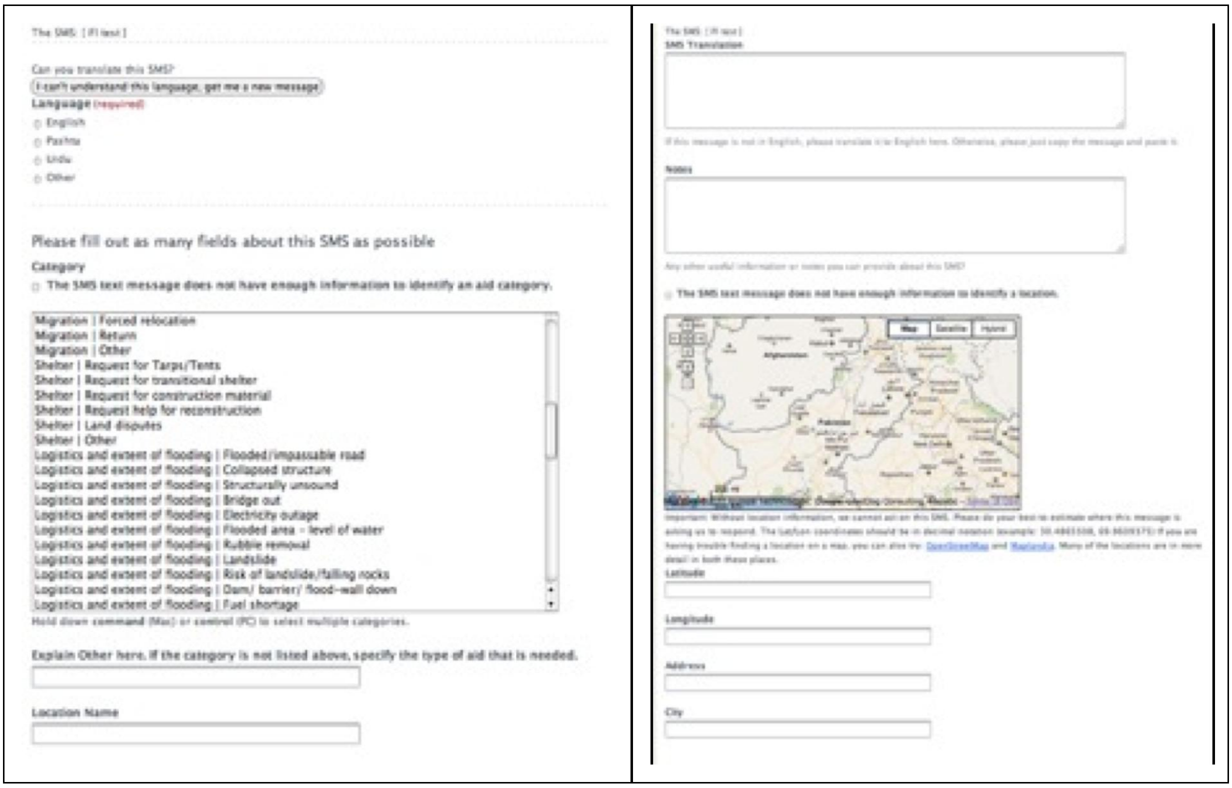
Figure 1: The Pakreport.org Operational Flow and Stakeholders



Details of the short code with the message "what you see about floods" was spread via the mass media – in particular via a partnership with the BBC World Service – and via relief agency workers. This led to a substantial increase in the volume of data being received, with the SMS channel taking over as the primary information source. This created a need to categorise the incoming messages depending on what was being reported, and then (if locational details were available with the SMS) geolocate the message so that it could be mapped.

Messages might also need to be translated from Pashto or Urdu to English. It was decided to crowdsource these microtasks via partner CrowdFlower. Volunteers from around the world participated in completion of the microtasks (see Figure 2). Because accuracy was critical to these efforts, CrowdFlower added a level of redundancy for improved quality control (as compared to previous disaster relief workflows), meaning that multiple volunteers evaluated each SMS message. This resulted in the collection of multiple points on a map, which the CrowdFlower platform then used to calculate the centroid of the points. This increased the accuracy of the final results being placed onto the online map.

Figure 2: CrowdFlower Disaster Message Analysis Microtask Forms



Because maps of and details about certain locations (especially rural villages and small towns in remote areas of Punjab and Sindh provinces) were not well developed or readily available, the Pakreport team created detailed online documentation (http://groups.google.com/group/PakReport-volunteers/web/mapping-links) to supplement these gaps. The team also provided training through Skype to manage 40 volunteers who assisted with this part of the process.

The map – with details, labels and annotations from the messages and other incoming data flows – was made available to relief agencies in Pakistan, providing real-time reporting for them. It was integrated with various ICT implementations; nationally in the UN and NGO sector (e.g. http://www.pakresponse.info) and the National Disaster Management Authority (NDMA); and provincially in the Provincial Disaster Management Authorities (PDMAs). The map enhanced the response efforts by improving prioritisation and coordination of the disaster response.

Formal Drivers and Objectives/Purpose for ICT Usage

Climate change is increasing the dangers of natural disasters for developing countries, such as flooding. Although the specific link to climate change is uncertain, the impetus for Pakreport was the massive flooding of 2010; in particular, the sense of isolation felt by those affected, and the limits on quality information for those responding. The objectives of this initiative were therefore a) to create an SMS-based line of reporting for the flood-affected people to communicate with the outer world about their situation on the ground; and b) to connect this information with the appropriate disaster response stakeholders to enable improved decision-making and relief efforts.

Stakeholders

As illustrated in Figure 1, this project brought together a very wide range of stakeholders. The main stakeholders were the local communities and flood-affected people who used mobile phones to communicate their emergency situation. Relief agencies and the general public who sought information about the crisis situation and who could respond to help requests were the end-stakeholders who received the information. Between these were many others:

- Media entities (e.g. BBC World Service radio, Internews) who helped spread the word about Pakreport
- The core Pakreport team
- Various volunteer groups (Crisis Commons, Crisis Mappers, Humanity Road) who participated via CrowdFlower in data analysis or who gave direct assistance to Pakreport
- Individual volunteers (from Fletcher University) who had worked on similar exercises in the past
- Technology partners (Pakistani cell phone providers, and CrowdFlower)

Impact: Cost and Benefits

Costs of Pakreport included: set up of the short code; monthly rental charges for the short code, hosting of the website on Amazon EC2 and managing logistics of the team working in Pakistan. Usually, the amount of technical and mapping resources utilised at Pakreport.org can cost in the range of US$10,000-15,000, but most of the team members and partners volunteered their time. Total cost of the project was US$7,000. The funding came from a fundraising campaign at globalgiving.org. Work space and office supplies were provided by Cogilent Solutions. The microtasking platform and technical services for integration were provided by CrowdFlower free of cost. Ushahidi instance customisation and code development for integration with CrowdFlower were also provided gratis. Three independent engineers also donated services: Chris Blow, George Chamales and Robert Munro.

Pakreport created a number of benefits:

- Collection of 1500 real time reports from the people on ground through SMS.

- Translation, categorisation and mapping of reports in near real time. Crowd volunteers completed over 2500 labels or categorisations of reports.

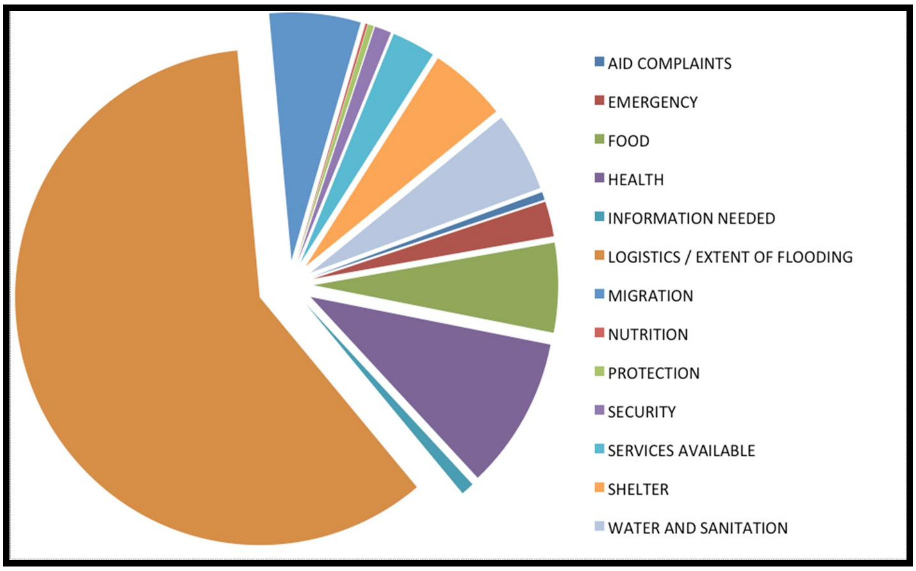
- Detailed knowledge and mapping resources organised by the Pakreport team (to view these map resources, please visit www.pakreport.org or refer to Figure 1.)

- A base for future crowdsourcing and mobile implementations in Pakistan. It would be easy to repurpose or duplicate this type of project. The growth and socialization of short code use and short code disaster reporting is an important component of the future uptake of similar implementations.

- Awareness of and dialogue about the effects of climate change. The collaborative reporting about the flooding and its aftermath contributed to environmental awareness as well as a clear channel for reporting and monitoring the environmental changes throughout Pakistan. Pakreport also represents an important and innovative technological foundation for ongoing, national-level reporting, monitoring and/or early warning efforts.

The breakdown of categorised messages in Figure 3 shows that the majority of categories were related to the floods themselves and their immediate effects like migration, shelter, water and sanitation. Among the largest categories, however, there was also security and protection. The affected populations were clearly concerned about their vulnerability to deliberate physical threats that were not directly related to the floods, especially among frequent rumours of aid groups becoming the targets of insurgent attacks.

Figure 3: Share of Messages by Category (Source: Pakreport)



Evaluation: Failure or Success

Evaluating Pakreport

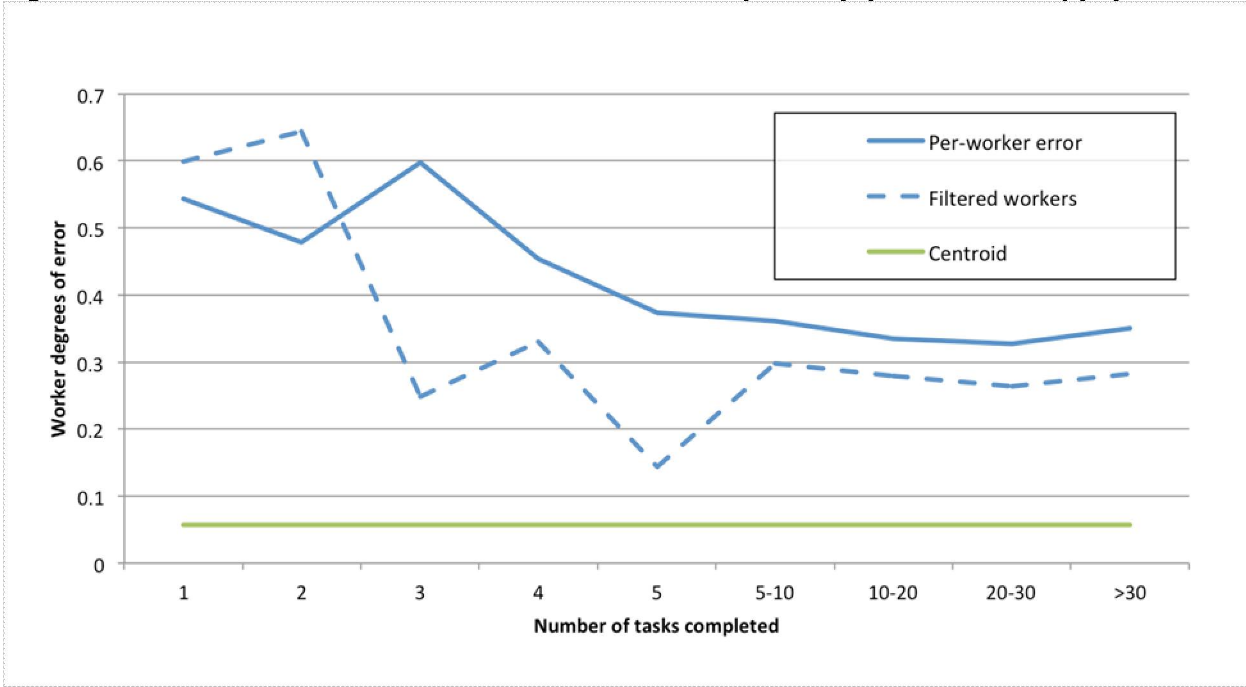
The project was successful in enabling rapid data moderation as a foundation for information exchange among various agencies and actors. Flood-affected individuals did not know about any platform to connect with the relief providers before or during the floods. The first responders were the Pakistan Army; but they did not have any mechanism to share ground-level information with other relief agencies. The information within the UN was managed through – but largely restricted within – the UN Cluster system (with a call centre to receive calls from ground and route this information to the UN agencies).

A primary success of the Pakreport platform is thus the creation of mapping knowledge and information in Pakistan that did not exist previously. A second success was the widespread use of mobile devices and a crowdsourcing platform to connect with people on the ground in a disaster situation. Mobile technologies, crowdsourcing and open data represent three emerging trends that have yet to be adopted by many nonprofits and relief agencies, especially in Pakistan. The collection and dissemination of this information created more focused, targeted and informed relief and response efforts. Relief actors were better able to direct time, resources and personnel as a result of open access to real time reports and requests for assistance from throughout the country. These efforts were also highly participatory in that they incorporated the survivors of the floods as well as flood-affected communities into the response efforts.

Evaluating Crowdsourcing Strategies

Figure 4 shows the average degrees of error between the volunteers working on the CrowdFlower platform and the final coordinates published in the Pakreport instance. The two most common types of error were omitting a category or confusing the services with requests. A typical example of the former is someone reporting "we need food and water", but only the "food needed" category is selected ("Water needed" is a separate category as water is a more time-critical need and also because some response agencies will focus only on ensuring clean drinking water). A typical example of the latter is someone reporting "There is a makeshift shelter treating the wounded" which is categorized as "medical attention needed" rather than "medical attention offered".

Figure 4: Worker Error Rates vs. Number of Tasks Completed (by Worker Group) (Source: Pakreport)



The first line shown, *per-worker error*, is simply the average degrees difference per worker after they have completed 1 task, 2 tasks, 3 tasks, etc. It shows improvement from the 3rd to the 10th task, indicating the volunteers became better at the task once they became more familiar with it, but not immediately so. The second line, *filtered workers*, excludes workers who averaged more than 1 degree of error. Predictably, after a few tasks filtration is a consistently more accurate strategy. The final graph, *centroid*, shows the method actually used in the deployment: the centroid of the locations identified by different workers (it is the average over all tasks, as the number of tasks is not as meaningful). It clearly shows that this was more accurate than taking any single worker's locations, even if that worker was substantially experienced.

To our best knowledge, no humanitarian organization has previously attempted to increase the accuracy of encoding by giving real-time work to multiple workers (crowdsourced volunteers or otherwise) so we hope that our analyses of different filtering/aggregation techniques can positively influence the decisions of humanitarian organizations that are considering possible information processing strategies. We did not filter workers during PakReport. Rather, we simply took the super-set of all categories they selected and the weighted average across locations. We explored the potential for filtering workers in post-hoc analysis of the data, simply because filtering high-error workers is standard practice in commercial microtasking platforms.

Enablers/Critical Success Factors

Crowdsourcing was critical to the success of this disaster response system. It was integral to the data input model, which would otherwise have relied on much more limited inputs from individual relief agency workers. It was not integral to the data analysis model, but its use greatly reduced the costs of analysis and mapping, and increased the timeliness and accuracy of those processes.

Although there was a need for innovation to fit the particular requirements of the Pakistan floods, in large part Pakreport **used existing technologies**. The bulk of its digital infrastructure was provided by the country's mobile phone system, which remained sufficiently operational; so there was no requirement for new infrastructural investments. Data input relied on a technology – mobile – that had already diffused to almost all parts of the country, and which was already familiar to, and in use by, the majority of the population.

Pakreport also made use of Ushahidi – a well-tried and well-trusted technology platform – rather than seeking to develop technology from scratch (something which, given the disaster timescales, would in any case have been impossible).

Related to this, the project **utilised established organisational expertise** in a number of ways. Because Ushahidi was the foundation, then members from Ushahidi Haiti and Chile implementations of crisis reporting and mapping platforms along with Silicon Valley engineers joined the Pakreport team in the first week after deployment. The team's expertise was substantial, and it included lessons learned first hand from the Haiti and Chile implementations. Similarly, partnering with CrowdFlower allowed the data analysis microtasks to be rapidly and scalably rolled out, rather than necessitated a new organisational infrastructure to be created. And linking up with radio broadcasters made use of their expertise and their existing technologies to publicise use of the SMS message system.

Finally, **altruism** can be seen to have played a role. Of course, some of those providing the SMS inputs were motivated out of their personal need for relief from this climate-linked disaster. But others were simply reporting what they saw for the benefit of others. Much of the technical development and all of the data analysis work was undertaken by volunteers; providing their time in the service of those affected. And individuals also took action on the basis of the reports they saw mapped, in order to organise their own direct relief activities.

Constraints/Challenges

The project had an **informational and technological not disaster response** focus at least in the initial stages. That is, the main work that had to be done was in setting up the software, web platform, data input and analysis and mapping processes in order to produce the map-based information. But this was separate from the disaster response effort so that coordination with the disaster relief agencies was at first quite limited. In large part this was due to the nature of application deployment – during the disaster rather than prior to the disaster when there could have been time to make relief agencies aware of the application, and to help ensure the information produced was being used to guide field decisions and actions.

A major challenge of any crowd reporting project is **verifying the accuracy and authenticity of the data** coming from the ground. In general the hope is that the volume of data will be such that good data drives out bad, but this may not always be the case, especially as crowdsourcing of climate-related data increases. There is no authoritative answer yet (and the dangers are probably greater during political crises rather than natural disasters) but some suggestions include weighting based on past data inputs, use of additional data such as locational or photographic, direct questioning of the source, and the possibilities for using language analysis software (Meier 2011).

Using mobiles and SMS enables any climate change-related project to reach a very large user population. However, there are still **digital divide** problems. For example by restricting inputs to three languages and by requiring a text-based message to be sent, Pakreport recognises that it did exclude some members of the population, such as illiterate mobile owners. Use of the web as the main reporting tool similarly meant that only a certain subset of the population was able to utilise the results.

Although recognising the great value of the complementarities brought by having so many stakeholders, this also brought the challenges of **negotiating agreements and reaching consensus**. With telecommunication providers, government departments, international agencies, the national media and others all involved, this added greatly to the transaction costs of the Pakreport initiative; something particularly challenging given the ever-pressing timescale of disaster relief. This required a great deal of time and effort; not just when formal agreements were needed but also in seeking to create less-formal consensus; for example around the rather-radical notion of collecting and then disseminating potentially unverified citizen reports.

Recommendations/Lessons Learned

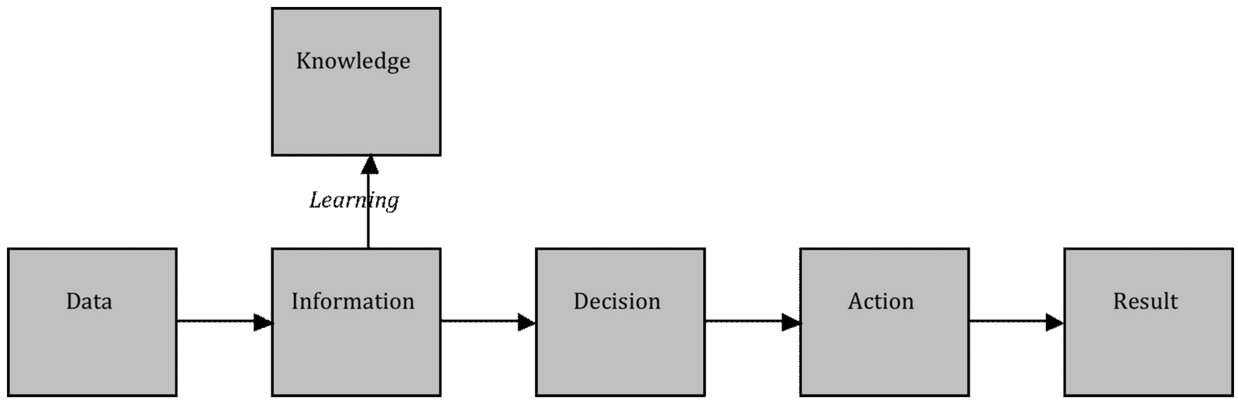
The following lessons were learned from this case study:

1) **Crowdsourcing can be highly powerful and effective for ICT-enabled climate change applications**. As seen, crowdsourcing can be used in at least two different ways – for gathering disaster / climate change data from a very broad set of users and locations; and for then analysing that data so that it can be effectively displayed and utilised. Although this particular application related to a climate-linked disaster, it is entirely feasible to use the same model for monitoring climate change e.g. by asking populations to provide information on local drought, rainfall, temperature, waterflow, etc. This would of itself also help to raise awareness about climate change; something that could be enhanced with a feedback loop by which those providing data would themselves also be sent short reports and climate alerts via SMS, web, etc. Locations at high risk of natural disaster and/or climate change effects should consider proactive establishment of this type of simple reporting workflow.

2) **Mobile-plus-Internet-plus-servers equals a system with reach and power**. On their own, mobile and Internet and server technologies have great value. However, the technological key to Pakreport has been its combination of the three. Mobile provided the reach down to the "bottom of the pyramid" populations who are on the front line of disasters and other climate change-related vulnerabilities. The Internet provided the reach and power to help coordinate volunteers across the world, and disseminate results to relief agencies. As the foundation, servers provided the power to collect, analyse, store and display the processed information. Other ICT-based disaster and climate change applications can therefore identify how to combine the reach and power of these technologies into an overall system.

3) **The full "information chain" must be in place**: the provision of information on climate-linked disasters is critical to effective disaster response and broader management. But the latter are only possible if there is a full "information chain" (see Figure 5); that is if there is a mechanism by which that information is turned into decisions about what to do and where and how to do it; and those decisions are then turned into actions on the ground. ICTs and climate change projects must therefore be designed around the entire chain, typically starting that chain backwards from the results that are sought and the actions necessary to achieve those results.

Figure 5: The Information Chain (Source: adapted from Heeks & Kanashiro 2009)



Data Sources & Further Information

Unless otherwise noted, the data and figures herein came from the CrowdFlower and Pakreport systems / databases and from the experiences of the authors: Faisal Chohan is a co-founder of Pakreport and a TED Fellow in Pakistan; Vaughn Hester is a Program Manager at CrowdFlower and helped set up the CrowdFlower task used to process Pakreport data; Rob Munro, a computational linguist, was a member of the Pakreport.org team.

For Further Information:

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A2. Role of ICTs in Early Warning of Climate-Related Disasters: A Sri Lankan Case Study

Author: Kanchana Wickramasinghe

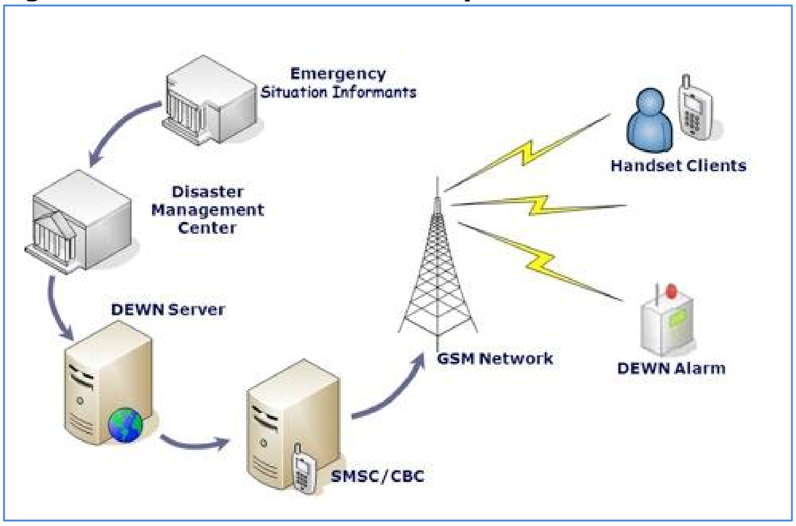
Initiative Overview

Climate change is now increasing – and will further increase in future – both the frequency and intensity of natural disasters in Sri Lanka including cyclones, floods and landslides (MoE 2010). While a number of strategies are necessary to address growth in climate-related natural disasters, an effective early warning system can play a crucial role in lessening the probable negative impacts. More generally, the need for such a system was highlighted following the huge devastation caused by the 2004 tsunami. After four years of research, development and piloting activities, the Disaster Early Warning Network (DEWN) was launched in Sri Lanka on 30th January 2009. It aims to provide timely, reliable and cost-effective mass-scale disaster early warnings. DEWN represents a multipartite effort and a case for public-private partnerships in delivering ICT-based early warnings.

Application Description

The DEWN server is located in Sri Lanka's Disaster Management Centre (DMC), the responsible agency on the island for all disaster management issues. The DMC receives early warning information from recognised technical agencies. Accordingly, information regarding floods, landslides, earthquakes and tsunamis is provided by the Irrigation Department, National Building Research Organisation, Geological Survey and Mines Bureau, and Meteorological Department, respectively. The DMC holds the responsibility for verifying the emergency situation and then issuing alerts. Emergency personnel are alerted first in the case of a potential disaster and public alerts are issued after the threat is further verified (DMC 2009).

Figure 1: Overview of the DEWN System



Source: Wijesinghe et al (2008)

DEWN's alerts are multi-modal; that is, making use of multiple technologies to disseminate information to the last mile. As shown in Figure 1, the end devices are normal cellular phones and alarm devices which were specially developed for this initiative. DEWN can generate mass, personnel-directed or location-based alerts to the end devices using the two commonly-available mobile communication technologies: cell broadcast (CB) and short message service (SMS)[1] (Wijesinghe et al 2008).

[1] CB is point-to-multi-point / broadcast technology by which messages are broadcast to all handsets which are 'listening' to the appropriate CB channel. CB can reach millions of handsets in a matter of seconds if they are listening. In contrast, SMS is point-to-point, where messages are individually sent to a known number, one after another. CB remains entirely functional even in the case of network congestion where SMS services are impossible to use (O2M 2010).

Figure 2: An Alarm Device Placed in a Hospital

SMS-based alerts are sent to the contacts, mainly emergency personnel (currently numbering around 1,500 people). Since SMS is not immune to possible network congestion that may occur during disasters, it is not used for mass-alerting. Instead CB, which is immune to network congestion, is used to send mass alerts. The content of the message follows the internationally accepted Common Alerting Protocol (CAP). Customised messages are trilingual (English, Sinhala, Tamil) and can follow a number of formats including alert, order for evacuation and 'no threat'[1]. They can be sent to individual or groups or to the general public in identified areas.

In addition, alerts can be sent to the specialised DEWN alarm devices which are designed to be kept in the public places such as police stations, religious/community centres, markets, hospitals etc. (see Figure 2). The alarm device can be triggered either by SMS or CB and includes a number of functionalities which are essential in emergency communications. These include an audible alarm, visual light alert, callback facility to a hotline number, backup battery, remotely and locally tunable FM receiver, and the ability to be used as a portable radio in day-to-day life. Its design thus provides a functionality before, during and after a disaster even in situations where there are power disruptions and the requirements for population movement (*ibid*). The device has been successfully tested, though further study and improvements are ongoing so that the device is not yet operational at national level.

Formal Drivers

DEWN was specifically initiated in response to absence of an effective, last-mile warning system for Sri Lanka, following the tsunami devastation in 2004. However, it was also designed to address climate-related disasters – cyclones, floods, landslides – since it was expected that climate change would aggravate all of these in terms of intensity and frequency over coming years (Parry et al 2007, Solomon et al 2007). In all cases, the most important missing link in disaster management was seen to be the difficulty of getting early warning information out to key emergency personnel and to the general public. This element of the information system is seen as the one most able to minimise the negative impacts of climate-related (and other) disasters.

Objectives/Purpose for ICT Usage

The traditional ways of disseminating disaster early warnings in Sri Lanka have been through radio and television, military forces and early warning towers. However, during a disaster situation, there are important limitations – mass media channels are not always switched on, and other channels have limited reach. In designing DEWN, then, the intention was – via the combination of cell phones (many of which are constantly switched on) and alarm devices – to enable early warning information to reach the last mile more effectively but also at relatively low cost.

[2] 'No threat' messages are used to inform people that the danger from the disaster is over.

Stakeholders

The DEWN initiative is a multi-agency collaboration which includes the government's Disaster Management Centre, Dialog Telekom Ltd. (a private mobile telecommunication operator), Microimage (Pvt) Ltd. (a private software development company), and the University of Moratuwa (UOM). The mobile operator initiated research and development activities in collaboration with the university in the Dialog-UOM Mobile Communication Research Laboratory. All funding and some technical assistance for this was provided by the company. Most software development activities were undertaken the software development company. Like Dialog Telekom, Microimage got involved in the initiative on non-commercial grounds. The ultimate stakeholders are the emergency personnel and general public who will benefit from the warnings, though cell broadcast alert messages to individual phones are only available to those who are Dialog Telekom subscribers.

Impact: Cost and Benefits

The costs of the DEWN initiative are very hard to estimate since they have been undertaken as an integral part of the activities of all the stakeholders, without separate and explicit costing. One of the few costs that is known is that of the alarm devices, with initial versions costing around US$190 each to produce. At the time of writing, DEWN had not been used in an actual disaster incident. However, the benefits can be expected to much higher than the costs. The main benefit of any early warning system is the saving of human life. It is hard to provide monetary estimates for this and such estimates as exist vary considerably. However, using figures from Hong Kong and adjusting for differences in GDP per capita gives a very rough estimate of US$150,000 per life saved in Sri Lanka (Siebert & Wei 1998). There will also be benefits in terms of any movable goods and assets that might be saved from disaster due to the early warning, with estimates of a 1:7 ratio between overall costs and benefits of investment in disaster early warning systems and other preventive measures (DT 2010). There are also some more quantitative benefits, from greater feelings of security within communities that can access the warnings, to reputational and other benefits for the mobile operator.

Evaluation: Failure or Success

DEWN is expected to be a successful example of an early-warning system suitable for addressing the growing threat of climate change-related natural disasters. However, since no such major disaster has befallen Sri Lanka since DEWN's implementation, no full evaluation can be given; only the assessment of pilot and trial exercises which have shown the value of mobile telecommunications in this area of climate change adaptation.

Given the innovativeness of DEWN, it received a number of pre-implementation awards including a National Best Quality Software Award and National Award for Science and Technology in Sri Lanka in 2006, a Vodafone 'World Around Us' Workshop Award in Cairo in 2006, and Commendation at the GSM Global Awards in 2007. The alarm device has also been patented.

Enablers/Critical Success Factors

- **Public-private partnership** has an important part of the success of this project. The public sector must be involved since the DMC is the responsible agency for early warning, and it provides the sole legitimate node that can draw on other public agencies for the early warning information. However, it lacks many key resources – money, knowledge, skills, and a nationwide mobile infrastructure. It was all of these that the private partners – Dialog Telekom especially – could provide.

- **Building on existing technologies** has been central to the project. Rather than try to set up a new, separate information system to deal with climate change / disasters, DEWN was built on the existing mobile network in Sri Lanka. This has brought many advantages. It has reduced costs. It has ensured long-term viability since the mobile network and its phones exist irrespective of the DEWN project. It has ensured strong penetration of the warnings given that mobile subscription rates have been growing by nearly 50% per year during the first decade of the 21st century, with 82 subscriptions per 100 citizens by 2011 according to data from the Sri Lankan Telecommunications Regulatory Commission. (More specifically Dialog is the market leader with a 39% share amounting to more than 7 million customers, and coverage of 75% of the island's land area and 95% of its population.) The high penetration rate and high market share for Dialog and the fact that many people have their mobiles on at any given time day or night (unlike radio and TV) mean that virtually all communities are likely to receive at least one warning, and most will receive many.

- **Integrating climate change into broader applications** helps. This was not a system designed specifically for climate change. Instead, it integrates the dangers of climate change – its exacerbation of natural disasters – into a more generic information system. Indeed, DEWN is broader also than just an early warning system since it can also be used to contradict erroneous messages about disasters, and to disseminate information on post-disaster operations.

- **Specific disaster-relevant design components** have been included. So – unlike some other early warning systems – DEWN includes an audible alarm warning. By being trilingual, it also minimises language barriers that would occur if, for example, warnings were only sent out in English or in Sinhala.

Constraints/Challenges

The **technology** has been a challenge in three ways. First, the ***cost*** of the alarm devices was initially quite high for a developing country context like Sri Lanka – more than US$400 – limiting its diffusion. Ongoing development work has reduced this cost by more than half, but the money for this – as compared to using the existing mobile network – has to be found from somewhere. In addition, there have been problems with some phones in use in the Sri Lankan market, which do not adhere to ***international standards***. As a result, it has been very difficult to get CB messages delivered to these phones. Technology has also proven a challenge to ***network interconnection***. At present, only Dialog subscribers receive the alert messages. Discussions have been held with other mobile operators to enable cross-network connectivity but this will only be possible with the necessary technology and infrastructure (and political will) to enable this interconnection.

Not yet a proven issue in Sri Lanka, but there are reports that mass alerts in certain other contexts have generated **panic and chaos** among the recipients at times of disaster (Jayasinghe et al 2006).

Recommendations/Lessons Learned

The following lessons were learned from this case study:

1) **Public-private partnerships can play a valuable role in ICT-enabled climate-related disaster management**. The situation with DEWN is not untypical where early warning systems are needed due to climate change and other causes: the public sector has legitimacy, institutional capital and reach; the private sector has technology, innovative capacity and other resources. Each provides what the other lacks and – if collaboration is well thought-through – each can be motivated to successfully work together.

2) **Mobile technology can be used now with limited additional investment**. Although, as seen, technology remains a challenge for early warning systems, those challenges would be far greater if projects required investments in new infrastructures and required users to make use of new, unfamiliar technologies. Mobile now provide a ready, increasingly-ubiquitous, increasingly-familiar technology in developing countries around which to base not just early warning systems but other ICTs and climate change applications.

3) **Multi-operator collaboration is necessary for fuller coverage**. Already, DEWN likely reaches into virtually every community in Sri Lanka. However, to ensure the fullest-possible coverage and to avoid concerns about economic or other gains being sought by one operator, it would be sensible for mobile-based, climate change-related ICT applications to be based around a multi-operator collaboration; something on which government partners could insist.

4) **Technology must be complemented by other actions**. Just rolling out technology is not sufficient for early warning systems. Instead, there must be awareness raising (via mass media and / or via phone) among the general public; there must be specific training for those using specialist devices like the alarm; and all this must be part of much wider training of emergency personnel for both early warning and disaster intervention response.

5) **Build climate change into existing disaster applications, don't built stand alone applications**. DEWN does not give any separate consideration to climate change – it focuses on effects and is thus "cause-blind". It thus addresses the effects that climate change may exacerbate but within a general-purpose application. Consideration of climate change thus comes at initial planning stages for early warning applications, to ensure that the type of disasters climate change may exacerbate are incorporated into the overall system design.

Data Sources & Further Information

The case study is based on published materials plus key informant interviews with the DMC, mobile telecommunication operator (Dialog), software development company (Microimage) and the mobile telecommunication research laboratory, who are the stakeholders of DEWN which, in turn, is seen as an integral component of the climate change response process in Sri Lanka.

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A3. Using Mobile Phones to Reduce the Adversities of Climate Change in Rural Nepal

Authors: Shradha Giri & Yuwan Malakar

Initiative Overview

The initiative described in this case is part of a disaster risk reduction project implemented by Practical Action in Nepal, financially supported by the UK's Department for International Development. The initiative aims to build resilience by improving the livelihood assets of vulnerable communities, and the work reported here focuses on the rural communities around Kirtipur in Nawalparasi District in South-Central Nepal.

The villagers rely mainly on agriculture, supplemented by seasonal migration for work. But the lack of technical and other inputs mean that agricultural outputs are limited to subsistence level. Inhabitants report signs of climate change including greater variation in precipitation and higher temperatures in both summer and winter, which is affecting agricultural use patterns and productivity. In addition, the area has a fragile geography, with agricultural and other land subject to flooding; a phenomenon that has been increasing in recent years. With a growing number of mobile phones coming into the area, this initiative sought ways to use these new ICTs to reduce vulnerabilities, including the vulnerability to climate-related disasters, and more generally to improve agricultural livelihoods. It did this by developing a phone-based early warning system allowing upstream and downstream communities to exchange information on flood signs and occurrences. It also developed a list of service providers and traders with whom the farmers could communicate for agricultural and value chain information.

Application Description

In this fragile and climate change-impacted environment, mobile phones have been making a contribution through their role as data communication devices to provide information on three critical areas:

i) **Agricultural practices:** alongside the typical problems of low-productivity agricultural practices and poor access to inputs, farmers in the villages are also reporting – with a presumed link to climate change – the arrival of new pests and diseases about which they have limited knowledge. This has affected the level of outputs because of the novelty of these challenges and the lack of availability of local agricultural technicians. The project provides the farmers with the phone contacts of technical service providers, which they have then used to get advice about treating crops and livestock. They also use this service for more general advice on seed varieties, planting times and methods with the aim of raising incomes and thus reducing vulnerabilities.

ii) **Market prices:** in order to reach the nearest market, farmers in Kirtipur have to walk 10km along a trail and then travel a further 5km by bus. Because of the higher costs of reaching other markets and the complete uncertainty about prices in those markets, farmers would always sell in the nearest market at whatever price the local traders would offer. With climate change and flooding potentially suppressing the level of outputs they could achieve, this was a severe threat to income levels. The project therefore also provided the farmers with a phone contact list of agricultural traders in a number of nearby markets. As a result, not only are they better informed about reasonable market price levels for their outputs, they can also compare prices between traders and justify journeys to whichever trader is offering them the best price.

iii) **Disaster early warning:** flooding – particularly the recent growth in occurrences and severity which is assumed to be linked to climate change – causes problems to the farmers in loss of crops and livestock, inability to access markets when there are landslides, and more general dangers to life and property. The project provided a phone list of key contacts in both upstream and downstream communities. When there is continuous heavy rain, those in the upstream areas phone and warn those in the downstream communities, who are then able to prepare and evacuate livestock, property, family, etc. They also warn about landslides that may block planned transport routes. In return, those in the downstream – more populated, better connected and more commercial – areas, provide information on markets, agricultural practice and development opportunities.

Of course the mobile phones are also used for other purposes – for contact with family and friends, including contact that enable money transfers; and for more formal contacts to government and private sector goods/services providers.

Formal Drivers

Paddy-wheat-maize was the dominant annual crop cycle of the farmers in Kirtipur but it was highly reliant on water for irrigation. Existing irrigation challenges were exacerbated by the recently-changing climate scenario. Longer periods of dry weather between November and May, greater flooding during the monsoon season, and erratic rainfall at other times of the year have all made irrigation problems worse, and have thus reduced crop yields. Villagers reporting all this during a participatory vulnerability assessment (PVA) conducted by Practical Action noted that some farmers were having to leave their land while they waited for rain.

The PVA also exposed the problems of the existing slash and burn system in which land was cleared of natural vegetation, farmed for some time, and then abandoned in favour of new cleared land. This increased the extend of landslides in upstream areas, of destruction by rocks and other debris carried down, and of flooding in downstream areas. Set alongside the problems of market pricing, it became clear from the PVA that there was an important lack of information around the three key areas already identified – agricultural practices, market prices, and disasters. This need coinciding with the growing incidence of mobile phones was the driver behind the project reported here.

Objectives/Purpose for ICT Usage

The project recognised that it was not possible to separate out the role of climate change within either agriculture or disaster management. But, recognising that the effects of climate change will be worse for those with weak livelihood asset bases, the project sought to more generally build the resilience of the communities involved by strengthening their access to information and, in turn, strengthening their productivity and income generation. Along with other interventions, the project promoted the use of ICTs to reduce vulnerabilities – including climate change vulnerabilities – and to help the communities avoid, mitigate and cope with the effects of climate-related disasters, and to adapt to the longer-term changes in the local climate. It aimed to do this by using mobile phones to provide greater access to information on (1) the production and marketing of vegetables, other crops and livestock; and (2) disaster risks.

Stakeholders

The leading actor to this initiative is the local community who were facing challenges to their livelihoods. The work was coordinated at local level by village development committees (the lowest level of local government in Nepal) and was led by "agriculture groups": groups of farmers affiliated with the District Agriculture Office. The international NGO, Practical Action, was the main project motivator, acting as the nodal point for all other stakeholders, and helping to identify and establish the various phone contacts points among the communities, traders, etc. It was supported financially by the UK's Department for International Development. Other than key community members, the main contact points were government-run agricultural and livestock service centres, private vets, and small shopkeepers and traders located in local markets. Contacts with the government agencies were facilitated by officials in the Nawalparasi District Development Committees and District Agriculture Development Office. Implicitly, the telecom service providers are also stakeholders since they provide the mobile phone services utilised.

Impact: Cost and Benefits

One thing the project did not pay for was either the mobile phones or call charges. In general, farmers paid something like Rs.3000-4000 (c.US$40-55) for a mobile phone with GSM/CDMA SIM card. Penetration rates increased to something like one phone per household once the mobile providers had – as part of their already-planned roll-out – placed the area within network coverage.

The project not only provided contact lists but also arranged interactions between the farmers and those they would call: in other communities, traders, agricultural service providers. As noted above, other community members would call and answer calls for free, on a kind of quid-pro-quo basis. Traders were willing to provide information on prices since it sometimes led to sales. Government-owned agricultural service staff made no charge since providing information and advice was part of their job; they also saved considerably through not having to visit Kirtipur, which was almost two hours travel from the district headquarters. Finally, private providers, such as vets, also made no specific charge because they could link this to selling other services to the farmers and could also save on travel time.

In terms of benefits, mobiles therefore helped by providing information that improved agricultural and disaster-related decision-making. They saved money and time significantly in terms of journeys foregone – carrying warnings between communities (not that this happened much in practice before mobile phones); bringing agricultural technical staff to the village; taking the farmers to markets. They also enabled broader benefits – higher yields, higher prices and less wastage of produce – that have lead to income growth. Downstream communities now have a lead time of one-two hours in warning against floods, which has enabled households to save not just valuable documents, belongings, animals, etc but also – and most importantly – lives.

Some wider benefits can also be seen. For example, patterns of farming have changed with more growth of crops overall and particular growth in planting of vegetables and cereals. Again, it has raised incomes particularly thanks to growth of cash crops like vegetables. The use of slash and burn has reduced, which is helping to maintain and regenerate forest cover, increase watershed health, and reduce landslide and flood hazards. In large part these benefits should be attributed to other project components such as the restoration of a dilapidated irrigation channel and direct advice and training sessions from visiting agricultural experts. However, by providing agricultural and market price information, the mobile phones have contributed.

Evaluation: Failure or Success

It seems appropriate to categorise this initiative as a success in terms of benefit obtained from investment. The linkages established last beyond the lifetime of the project and provide more opportunities and enable farmers to build more confidence and social capital. Income from agriculture has been increased particularly from vegetables. Increase in incomes and strengthened livelihood options have paved the way to resilience. Slash and burn has been decreased giving the watershed an opportunity to improve its health. Risk of life and other loss from flooding has been decreased. Of course, the ICT is just one among a raft of elements but it does appear to be helping these vulnerable communities not just avoid and recover from disasters, but also build a deeper adaptive capacity (particularly in relation to information, skills and income) that will enable them to cope better with the longer-term challenges of climate change.

Enablers/Critical Success Factors

The key to understanding success or failure of any project involving ICTs and climate change, is to **understand the motivations of the people** involved. This project has worked well – and seems likely to sustain in future – because virtually all the stakeholders involved derive some benefit from it.

Of course, the hardships faced the communities due to poor agricultural productivity and the damage done by flooding were a strong motivator for the prime beneficiaries and, as seen, the delivery of higher outputs, income generation and some protection from climate-related disasters ensure continued motivation and participation. However, motivating core beneficiaries in a project is relatively easy. Harder is to motivate the secondary stakeholders on whom success of the project still, nonetheless, rests. But in this case, the project does seem to have created a win-win because those other stakeholders – other community members, traders, agricultural service providers, even the mobile providers – find themselves gaining something in return for their involvement: information and/or direct income and/or savings due to foregone journeys.

Technology itself was an important enabler: the project would most likely not have worked if farmers could only get mobile network coverage when they travelled to nearby towns. But more important was the role of technology within the project. Unlike many ICT projects in development, this one **did not invent or introduce anything new**. Instead, it relied on a technology – mobile phones – that were already (albeit quite recently) in quite widespread use within the project area. Instead of the "inorganic" project approach that brings in a new technology from outside, we can therefore call this an "organic" approach that built from the existing foundations. It did not seek to innovate technologically; instead it innovated socially and commercially using the base already present. It did not require a project intervention to cause mobiles to be used in this rural area. But it need require Practical Action's intervention to cause the mobile to be used in a way that facilitated disaster management, agricultural productivity, and longer-term building of resilience to climate change.

Constraints/Challenges

Notwithstanding the point above about mobiles now being an "organic" technology within many developing country villages, the timing of this project just as mobiles were diffusing into the community did present challenges. **Most users were new to mobiles and unfamiliar with them**. The majority of Kirtipur's citizens were illiterate and the phone fascia and any related text were in English, further lengthening the learning curve. Being without electricity, villagers had no access to television – which ran informational broadcasts about using ICTs. Thus it took some time for those involved to become familiar and then confident with using mobiles.

And, notwithstanding the point above motivation of participants, the **validity of some of the information provided was sometimes questionable** but hard for the villagers to assess due to their limited broader knowledge on issues. Information on market prices was not always reliable (for example, sometimes traders did not wish to buy items and so were not motivated to provide a correct price), though comparison across traders could help avoid this problem. And there were concerns about false positives in the reporting of flood dangers. There could be a number of instances of flood warnings being given and leading to households, etc being moved but then no flood ensuing; particularly as there was no objective measurement of rainfall by the upstream communities. Such instance would eventually lead to flood warnings being ignored.

Recommendations/Lessons Learned

The following lessons were learned from this case study:

1) **Mobile phones can form a key foundation** for ICTs' contribution to climate change adaptation generally, including disaster management more specifically. In very many – and an increasing number – of developing country locations, mobile phones are already in place and in use. The work of disaster and adaptational projects therefore becomes not the introduction of a new technology, but the introduction of new ways of using the technology.

2) **Simple applications can still be effective**. At root, this project did little more than providing a mini-phone book for project participants. Yet, given their lack of social capital and their lack of broader knowledge, this had quite a significant impact in providing disaster and agricultural information which then had broader knock-on impacts on livelihoods that strengthened resilience and capacity to adapt longer-term to climate change.

3) The ability to avoid and cope with disasters, and the ability to adapt to climate change depend on many components – assets, institutions, structures – etc. However, **money remains critical**; likely to most important single prophylactic against the vulnerabilities that climate change can intensify. Adaptational projects can therefore benefit if they incorporate income-raising and income-diversifying components, as this one did in relation to agricultural productivity and sales.

4) There are many success factors in a project, but **human motivation** is arguably the most important. If ICT and disaster/climate change projects can provide a good answer to the question, "What's in it for me?" for the key stakeholders, it will be far more likely to succeed. In turn, understanding what will answer that question will often depend on a detailed and participative initial assessments of needs, wants and values.

Data Sources & Further Information

Published and unpublished reports (monthly, quarterly and annually) from the field were the major source of data for this case study. Baseline information was collected using a participatory vulnerability assessment conducted at the start of engagement with Kirtipur. Field verification of the information was done when community meetings and focus group discussion were organised.

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Part B: Case Studies of *New ICT Routes to Climate Change Adaptation*

B1. Participatory Video for Monitoring and Evaluation of Community-Based Adaptation to Climate Change

Authors: Isabelle Lemaire and Soledad Muñiz

Initiative Overview

In recent years, extreme climate events have negatively impacted many parts of the globe, but due to its already high vulnerability, Sub Saharan Africa has been the theatre for some of the early and more dramatic climate impacts. This has affected most significantly the livelihoods and health of the most deprived people. As observed in the countries concerned by this case study (Malawi, South Africa, Kenya and Zimbabwe), droughts, floods, extreme temperatures have caused successive crop failures, the drying up of water sources and the spread of malaria to locations where it was not endemic (Koelle et al 2010; Wakhungu et al 2010; Zvigadza et al 2010).

Between 2008 and 2011, Community-Based Adaptation in Africa (CBAA) – an action research project – tested tools for community adaptation and knowledge generation in eight African countries while building the capacity of its partners and local communities. Through participatory methods[1], the project helped the selected communities to adapt to climate change and share lessons learnt with key stakeholders at local, national, regional and international levels.

The International Institute for Environment and Development (IIED) invited InsightShare to pilot participatory video for monitoring and evaluation (M&E) of this project to support their internal learning processes, inform the action research, and amplify community voices in relation to local adaptation to climate change.

Between 2009 and 2010, InsightShare held workshops in four of the eight participating countries: Malawi, South Africa, Kenya and Zimbabwe. InsightShare passed on skills in participatory video and monitoring and evaluation to build the capacities of community members and staff from the community-based organisations (CBOs) and non-governmental organisations (NGOs) implementing CBAA in each country. This enhanced the partners capacity to listen to the community members in their search for local adaptation strategies, and to monitor their pilot projects and climate-related indicators.

Application Description

Participatory video (PV) is a set of techniques used by a group or community to help them shape and create their own film. Making a video can be easy and accessible to all, and PV is a great way of bringing people together to explore issues, voice concerns or simply be creative and tell stories. This is an empowering process: enabling a group or community to take action to solve their own problems and also to communicate their needs and ideas to decision-makers and/or other groups and communities. As such, participatory video can be a highly effective tool to engage and mobilise people and to help them implement their own forms of sustainable development, based on local needs.

[1] A specific tool for mapping vulnerability called LOCATE (Local Options for Communities to Adapt and Technologies to Enhance capacity) was used prior to the participatory video component of this project. Although the participatory video methodology and LOCATE were not officially integrated, the PV for M&E initiative served to further enhance the findings initially yielded by LOCATE. For more information on LOCATE, please refer to: www.acts.or.ke/reports/RelatedResource/CBAAbrochure.pdf

When using participatory video for monitoring and evaluation, we combine the iterative and highly responsive nature of the former with the more systematic structures of the latter, providing a rigorous but engaging process that includes triangulation of different evidence sources. In CBAA, PV played a key role in further involving community members in discussing how climate change was affecting their lives and what were their suggestions for pilot adaptation projects (in the baseline process). It also contributed to monitoring and evaluating both these adaptation projects and climate variability.

Both the production of the films and the diffusion of local voices on adaptation to climate change were key aspects in the project as they allowed for increased participation in the action research process. The video products helped raise people's voices so they could be heard by decision-makers who were subsequently shown the films as part of each local dissemination strategy (see discussion below on impacts for more details).

Formal Drivers

The link between climate change and extreme weather events is complex, but it does seem clear that such events are increasing, and will continue to increase, as a result of climate change. Droughts, floods, heat shocks and other extreme weather events are on the rise in Africa. These have huge negative impacts on people's livelihoods, health, wellbeing and the local economy. In South Africa, a severe drought has been affecting the people in the Suid Bokkeveld, south from Nieuwoudtville in the Northern Cape. In Kenya, droughts, floods and above average temperatures have become more frequent. In Zimbabwe, temperatures have increased and rainfall decreased. In all the cases the climate variability has had strong effects on people's access to water. This has directly affected their livelihoods and health, as many of those communities are dependent on rain-fed agriculture (Koelle et al 2010; Wakhungu et al 2010; Zvigadza et al 2010).

The overall CBAA project was driven by these climate-related threats to livelihoods in Africa. In turn, for the CBAA initiative, PV was seen to have potential as an effective and rich learning tool for harvesting new strategies on community-based adaptation. It was seen as a means by which to better inform local NGOs on how to improve aid delivery for adaptation, as well as spread the community-based approach when dealing with the impact of climate change.

Objectives/Purpose for ICT Usage

CBAA decided to use participatory video and M&E as a means to enable the communities to record the impacts and the local adaptation knowledge in their own words. In addition to amplifying voices of the community, the activity also aimed to enhance accountability, support action research, strengthen communication between the NGOs and the communities, and help generate and archive local knowledge.

The aim with PV was for people to easily convey their knowledge, come together to discuss important issues in their daily lives and craft their message in an accessible and inclusive format. These are some of the reasons why CBAA partners considered it an appropriate tool to involve the communities in monitoring and evaluating change linked to the proposed local adaptations as well as climate variability.

Stakeholders

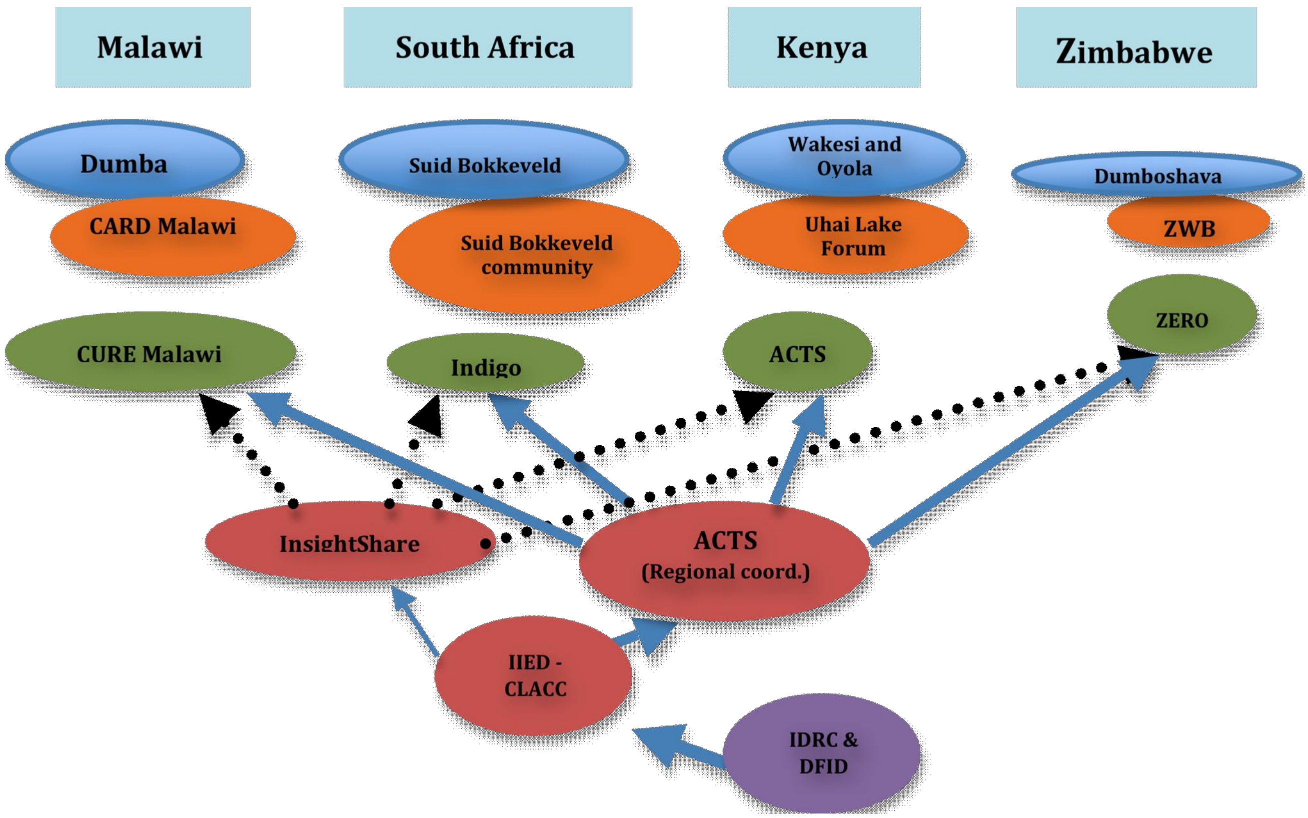
The project stakeholders are summarised in Figure 1. The country level coordinating partners were members of the CLACC (Capacity Strengthening for Least Developed Countries for Adaptation to Climate Change) network, a group of fellows and international experts working on adaptation in least developed countries, coordinated by IIED. The Department for International Development (DFID) and the International Development Research Centre (IDRC) funded the project. The regional coordinating partner was the African Centre for Technology Studies from Kenya.

The in-country partners were:

Country	Non-Governmental Organisation (NGO)	Community-Based Organisation (CBO)
Kenya	The African Centre for Technology Studies (ACTS)	Uhai Lake Forum
Zimbabwe	Regional Environmental Organisation Zimbabwe (ZERO)	Zimbabwe Women's Bureau (ZWB)
Malawi	Co-ordination Unit for the Rehabilitation of the Environment (CURE)	Churches Action in Relief and Development (CARD)
South Africa	Indigo	Suid Bokkeveld Community

CBAA worked with local communities, CBOs, NGOs, national meteorological services, researchers, and national and international policy and decision makers. The partners used a 'learning-by-doing' approach to reduce vulnerability to climate change. This involved identifying ways of communicating climate information to vulnerable communities and then from those communities onto other stakeholders.

Figure 1: Stakeholders for Participatory Video within CBAA Project



Communities
Community-based organisations
Non-governmental organisations
Coordinating partners
Donors
Training: Black dotted arrows
Funding: Blue arrows

Impact: Cost and Benefits

The total cost for running the PV M&E initiative within CBAA was approximately £45,000, including £7,000 for equipment. This was run as a pilot experience, thus considered as an investment from InsightShare. It was therefore costed at lower-than-normal rates and the planning time was for the most part invested and not covered by the grant. This lowered cost allowed for more countries to be covered and therefore more experimentation, but only allowed for one visit per country and a very basic camera kit to be purchased per project.

During the workshop, the trainees and communities carried out a baseline using PV (except in South Africa, where this was conducted after the training), creating a video on the current state of climate-related issues that affected people's lives. The training lasted 12 days and an average of 11-12 trainees took part. Most of them were community members (approximately three quarters) and the rest were CBO or NGO staff.

The trainees initially received PV M&E training and then went into the communities to undertake fieldwork, involving facilitation, filming and reflection: see Figure 2. On return they learned to edit and put the film together. They then went straight back to the communities to screen the films, reflect and receive approval and consent from the communities over the final film. Finally, they planned their monitoring process and the follow-up plans.

Figure 2: Participatory Video in Action

The final film was screened to the wider community, as well as to local decision-makers, and in some cases, to the national meteorology bodies in each country. With permission from the local communities, they were also uploaded to YouTube for further diffusion and presented in international climate change-related events. To view them please visit[2]:

- Malawi: http://www.youtube.com/watch?v=xHbGpxIumWU
- Zimbabwe: http://www.youtube.com/watch?v=iAOWp4i86KE
- Kenya: http://www.youtube.com/watch?v=n1ikM5ka8JY

[2] The South African project participants opted to keep their participatory video work offline for the time being. This choice was dictated by the preference of the community members to keep the footage as an internal reflection tool.

The project funds also allowed for the provision of ongoing backstopping and online support during the monitoring process and a final evaluation as well as a peer-review. The final workshop included another M&E tool: Most Significant Change, and the purchase of extra equipment needed for some of the partners and local communities.

The main benefits included:

- Community engagement in the baseline mapping of climate-related issues
- Development of participatory climate-related indicators, including initial mapping, and ongoing monitoring & evaluation
- Equipment left with the CBOs/NGOs and in some cases (Kenya) local communities
- Participatory videos informing the adaptation strategies and supporting the action research with rich qualitative information not previously available
- Local voices meeting with policy and decision makers at national and international level through film screenings (e.g. local authorities, meteorological offices, COP 15, among others. See below for more details)
- Capacity building of CBOs, NGOs and community members that participated in the training
- Adding value to the accountability and local empowerment process
- Helping community members to archive their local knowledge

Films were used to draw attention from the Kenyan authorities on how climate change was already affecting many rural communities. Charles Tonui, from ACTS, told us: "*When we showed the film to the local authority, they were surprised. They hadn't taken into account that climate change was actually impacting communities in their constituencies. It really made them realise they had to do something, now."*

The PV activity helped raise awareness on the need for alternative livelihoods at community level that would assist them in facing climate variability. For example, the Kenya Agricultural Research Institute (KARI) supported the planting of a different variety of mango tree in Wakesi, which is expected to perform better in the current climate conditions of that region, which should in turn help farmers access new markets.

In Zimbabwe, the project gained stronger support from the Meteorological Office once they watched the community-made film: *"We finally got the climate projections from the Zim Meteorological office. They were chuffed to see the film on DVD, and they have also given us a dedicated person to work with us on the CBAA project, (field and workshop)."* Shepard Zvigadza, ZERO Zimbabwe.

Evaluation: Failure or Success

At the stage that InsightShare became involved in CBAA, most projects had already worked with the community using different participatory learning and action tools to identify local problems and potential activities to implement. Despite this, the NGO and CBO trainees were surprised by the amount of new, mostly qualitative, information they were able to gather in the PV baseline. These new insights helped them decide which adaptation activity to pursue as pilot projects.

In Zimbabwe, for example, the PV baseline provided information on the linkage between climate change and HIV/AIDS, soil degradation and livestock climate-related issues. "*We realised the extent of the problems, how serious it was and we actually saw it*", reflected Shepard Zvigadza from ZERO.

The local screenings of the community-authored films were attended by large audiences (over a 100 people in each country) and attracted participation from young and old, men and women. The debates and information gathered after the screenings was very rich and helped further the research. ZERO, in Zimbabwe, identified new possible adaptation strategies as the community became more involved in identifying problems and suggested improvements through the participatory video intervention. For example: they suggested use of rope and washer water pumps since access to clean water had been getting more and more difficult.

The PV for M&E activity also enhanced participation. It built common ground between NGO/CBOs and the communities, and strengthened the capacity of the trainees in video, M&E and facilitation. The process raised awareness and mobilised people on the ground. This provided a platform to empower women's voices, intensify the quantity and quality of participation.

Particularly about women's participation, Shannon Parring from Indigo, South Africa, reflected: *"Men and women respond to and are able to adapt to climate change differently. Women are not just victims but active agents of change. They possess unique knowledge and skills that should be acknowledged and tapped into to support local adaptation processes. The PV method allows women to share their stories and views from a safe place, with the comfort of being in charge of what will actually be shared with a wider audience."*

Some women in Kenya also told us: *"I didn't go to school for as long as the men here, so often, in community meetings I just keep quiet. But with the video, I was able to participate and say what I thought! I felt so good!"* (Translated by Charles Tonui, ACTS)

Community engagement in the development of indicators was integral to the training. In Malawi, the participatory indicators increased motivation and ownership over the process. As the trainees selected the indicators, they knew what footage to collect and were eager to do it, creating an excellent film. In South Africa, the farmers wanted to monitor water fountains, and they combined the use of participatory GIS mapping of water resources, borehole level monitoring, monitoring of water quality and participatory video. Besides filming and documenting all the participatory baseline process, after they took the GPS points for the map, they recorded short stories about each water source, interviewing farmers.

> *"In the participatory monitoring process, everybody observes aspects and events that are important to them and if necessary decides how to change the course of action so that further errors are not continued or multiplied. The farmers used participatory video to record the usage, quality and variability of the water source as well as any important stories. The participatory video will be used to review in three years time if and how the water situation has changed. This reflection process offers rich learning – and creates the space for action that will anticipate possible changes in crucial natural resources such as water."* Bettina Koelle, Indigo, South Africa.

In Kenya, the trainees and researchers were able to identify community issues and strategies that were not highlighted by the community using other participatory tools. Among these were the effects of drought, floods and socio-economic issues affecting them in general. *"Adaptation is a slow process. Through PV, we can capture learning and share it with other groups. It helped us capture a clear and visual baseline that will facilitate the horizontal sharing activities we promote in our farmer field schools. Seeing adaptation on screen, in a peer-to-peer exchange is tangible and the ideas become easier to grasp for the farmers but also local decision makers. We've found the calendar useful, we could adapt it to the actual weather events and this way we kept filming and recording progress in the community."* Dan Ong'or, CBO Uhai Lake Forum, Kenya.

The films also allowed the NGOs to share lessons on community-based adaptation to a wide audience. Some of them were part of the "Development and Climate Days Annual Film Festival" that IIED organises around international climate talks every year[3].
The films from Kenya and Zimbabwe were screened in Copenhagen for COP15 where representatives of those NGOs were present and taking part in the wider conference. This helped them showcase their adaptation activities and share the climate related issues to an international audience. On a national level, the films were used with decision makers to draw their attention to the importance of climate adaptation.

[3] See: http://www.iied.org/climate-change/key-issues/climate-negotiations-capacity-building/development-and-climate-days-annual

Enablers/Critical Success Factors

1) The success of the process was underpinned by the '***learning by doing'*** approach of participatory video combined with the commitment by the partners to this way of working. Climate change adaptation is taking shape in a variety of ways across the globe, and because it is an emergent phenomenon, agencies cannot necessarily replicate existing methodologies to analyse its impacts. Only through working together with the people that are on the front lines of climate change can we all learn to provide aid that is relevant and timely.

Projects that link to adaptation must be responsive, receptive and flexible enough to assimilate new information harvested through community processes into project implementation plans. Furthermore, for this initiative, all parties agreed to learn, experiment and develop the tool. This provided lots of freedom to try new approaches and innovate. The logistical support given by the local NGOs was also a key ingredient needed for success.

2) Participatory video is an ideal tool for ***"putting participation first and foremost"*** and this fitted perfectly with all of the methodologies used by the CBAA partners that were already based on a deep participatory ethos. This enabled the participants and project coordinators to embrace the participatory-video-for-M&E process as an opportunity to learn and share knowledge harvested at community level. This allowed for ongoing re-adjustment of the project plans and the scope of research; a necessary step in a field such as adaptation, which is highly unpredictable and where new findings are constantly produced.

To allow full participation, the partners were able to make the monitoring and filming process more accessible through multiple visualisation techniques (including drawing of indicators and the creation of storyboards to plan the films).

3) The organisations had a learning agenda, which allowed for experimentation and ***openness to unexpected findings from the interaction with community***. Due to the lack of data on current and predicted impacts of climate change, the qualitative information gathered through PV-for-M&E fed and advanced the action research. This counters the more traditional style of monitoring, which may not always allow for information outside the expected categories to be recorded. In climate adaptation, where there is yet so much to be learned, participatory video for monitoring and evaluation can act as a valuable complement.

Being opened to unexpected findings also means not being tied to planned outputs, but instead informing those with new feedback. The partners were open to learn and adapt to the needs of the community and prioritising these actions rather than the implementation of adaptation strategies devised at NGO level. A clear example of this is the project in Zimbabwe where the planned intervention shifted from digging out a dam to installing more reliable wells, as a result of listening to the community needs through PV for M&E.

Constraints/Challenges

There were several challenges in implementing the project, including ***managing the expectations of communities*** who did not see the immediate benefits of the monitoring and research process. These were addressed through the capacity building aspect of the initiative. The partners built on the skills of community trainees, leaving equipment under community management and creating a forum through screenings and discussions to highlight community action priorities related to CBAA. In particular, leaving flip cameras with the community was an effective motivator in Kenya, enabling the punctual recording of climate events to be shared with the local NGO as well as local authorities. The flip cameras were left with village committees while the PV kit was left with the community-based organisation.

Demanding time from local people requires careful management – while their basic needs are so pressing it can be difficult for people to see knowledge gathering as beneficial. It would therefore have been unreasonable to ask the community to keep filming a strict set of indicators following a rigid calendar for a period of over one year. The partners therefore created a flexible calendar with a loose set of indicators gathered in broad categories. This was not as systematic as traditional log frames, but it suited the context and purpose of the activity. It was also decided that the CBO staff – being closest to the communities – would visit the villages at agreed periods and facilitate the filming of indicators.

Recommendations/Lessons Learned

These are some of the main recommendations and lessons learnt harvested from the process:

- ***From blueprint to process: balance consumption- and production-oriented models of participatory video***: Climate change adaptation is a long-haul activity where the focus needs to be on building lasting resilience and capacity. One – consumption-oriented – perspective on PV focuses on immediate actional impacts; asking how the information generated by PV has been used. While this is clearly important, it should be balanced by a production-oriented perspective that asks how the process of creating PV builds skills, knowledge, confidence, etc within communities. It is these latter which empower communities and contribute to the resilience and capacity to adapt to climate change long-term. This – like other enablers and lessons reported here – can be seen as part of a broader orientation necessary when using ICTs in climate change adaptation: the need to turn from a blueprint to a process approach (Walton & Heeks 2011).

- ***Be rigorous about climate change indicators and M&E***: Adaptation is hard to pinpoint and categorise, especially trying to prioritise strategies that focus on climate change adaptation rather than what is already being achieved through development projects. It is therefore important to clarify with the community what the significant indicators are that can relate back to adaptation. It is also important to provide a thorough and rigorous M&E framework to ensure that a broad range of issues are covered and an appropriate sample of the community has participated. This helps build credibility, reinforces a feedback loop and therefore improves accountability. Above all, it enables reflection for learning at multiple levels.

- ***Involve the community in selecting the participatory M&E tools***: PV allowed for communities to identify geographical areas that are becoming vulnerable because of climate variability. They physically needed to prioritise areas to film in where there had been climate impacts and where people are focusing their attention in addressing these impacts with various coping strategies. When using participatory video to establish a baseline it is important to use participatory M&E methods that make sense to the local community, for example when choosing sites for mapping or to develop indicators for other approaches. This will make the monitoring process easier, as the framework is not imposed and is one of which the community feels part of and can make sense of.

- ***Select appropriate technologies and climate-related indicators:*** PV can be very powerful in recording climate-related indicators because it gives in situ insights on what is actually happening on the ground. These indicators however need to be carefully selected so that they fit the video medium. More numbers-based indicators, for example, the loss of cattle due to drought over a long period of time, could not be recorded on video. However, the state of erosion of a riverbank or an interview with a woman on her changing access to water are excellent topics to record with PV. In South Africa, the development of a baseline using PV and participatory GIS mapping proved to be a very flexible and adaptive approach that worked well for that specific community.

- ***Ensure PV data is manageable:*** Adaptation to climate change is a complex issue and PV will be best used when the level and quantity of information is limited to the most important and crucial indicators so as to limit the amount of video data to manage. Video data needs to be logged and archived on a regular basis, especially if filming takes place during an extended period of time. This process requires a fairly advanced understanding of data management and can be time consuming. Reducing the number of indicators and frequency of collection, and allocating more training time to data management could solve this. In Malawi, the process was simplified through the identification of specific locations in which to film during weather events, of a targeted list of questions to ask during interviews and of specific crops to monitor.

Participatory video is a powerful tool to ensure that learning is harvested in a human and accessible way about how communities are coping with climate change. But more importantly, it can also be used to help determine the most relevant and pressing adaptation strategies as it promotes listening, sharing and consensus building within communities and across to intervening NGOs.

Data Sources & Further Information

This case study was developed from three main sources: the senior facilitator's and project manager's direct observation and experience in each country; interviews with NGO/CBO staff; and CBAA and InsightShare reports and documentation.

For further information see:

- Videos: http://insightshare.org/watch/video/dumba-malawi
- Photo story: http://insightshare.org/resources/photostory/cbaa

Information is also available at stakeholder websites:

- CBAA: www.acts.org.ke/reports/relatedresource/cbaabrochure.pdf
- IIED: www.iied.org
- InsightShare: www.insightshare.org

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B2. ICT-Enabled Knowledge Sharing in North-South Partnerships: Lessons from the AfricaAdapt Network

Authors: Dr. Blane Harvey and Dr. Tom Mitchell

Initiative Overview

Knowledge-sharing tools and networks relating to climate change adaptation increasingly draw on Web 2.0 functionalities and user-generated content. These contribute to a shared evidence base upon which current and future adaptation planning and action (at a range of scales) can draw. They can help to build a community of practice around climate change adaptation, validate adaptation processes and information, offer users a sense of potential options and outcomes from adaptation actions, based on others' experiences, as well as space to document their own experiences (Hammill and Tanner 2011; Ecofys and IDS 2011).

AfricaAdapt is one such knowledge-sharing network on climate change adaptation in Africa, established in 2008 and hosted by four partner organizations: Environment and Development in the Third World (ENDA-TM), based in Dakar, Senegal; the Forum for Agricultural Research in Africa (FARA) in Accra, Ghana; IGAD Climate Prediction and Applications Centre (ICPAC) in Nairobi, Kenya; and the Institute of Development Studies (IDS) in Brighton, UK. The network describes its aim being "to facilitate the flow of climate change adaptation knowledge for sustainable livelihoods between researchers, policy makers, civil society organisations and communities who are vulnerable to climate variability and change across the continent" (AfricaAdapt, n.d.).

Since its launch it has grown to over 1,100 members (80% of whom are Africa-based) (as of 2011), consisting primarily of researchers and practitioners working on climate change and development in Africa. AfricaAdapt is funded through the UK Department for International Development (DfID) and Canada's International Development Research Centre (IDRC) under the Climate Change Adaptation in Africa (CCAA) programme and is intended to offer a space for its members to profile their work, access African adaptation research in a range of formats and languages and establish new connections (both online and face-to-face) with others working on the topic.

Application Description

The geographical distances between each of the partner organisations, and the continent-wide target area for membership, means that ICTs play an important role in facilitating and mediating relationships in AfricaAdapt. Among the four host partners key technologies that are used include Web 2.0 tools such as Skype, wikis, and Delicious, as well as more conventional tools such as e-mail.
Use of these tools was also seen as a form of institutional capacity-strengthening in line with the above-mentioned aim of "promoting a culture of knowledge sharing", and to this end the team members charged with implementation of the network's activities (its Knowledge Sharing Officers, or KSOs) were provided with ongoing training and mentoring on the identification and use of knowledge-sharing tools (c.f. Jackson 2010; see Figure 1). In communicating with, and facilitating knowledge sharing between, AfricaAdapt's members however, a different range of networking and knowledge-sharing tools are employed, including Twitter, YouTube, and a bespoke online platform that allows for the creation of user and project profiles in a style similar to that of Facebook and other social networking sites.

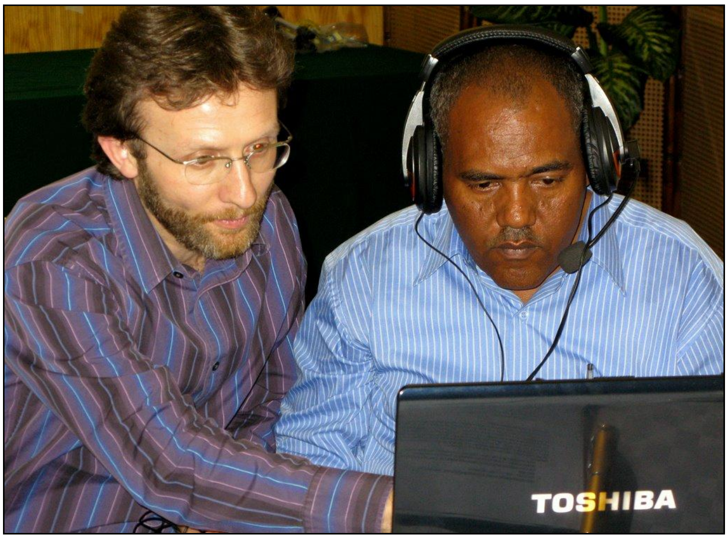

Figure 1: KSO Training

The discussion of lessons in this case study will focus primarily on selection and deployment of ICTs to facilitate management and implementation between the four host partners, though we note that learning from the use of ICTs in internal management appears to influence subsequent strategies for engaging with the network's members. In particular we look at lessons on how the selection and use of particular ICTs as partnership management and information sharing tools create meaning and shape relationships. We also look at how the people, politics and protocols of this heterogeneous network of partners *shaped*, and simultaneously were *shaped by*, the use of these ICTs.

As activities aimed at addressing climate change and development are increasingly designed on networked and collaborative models a better understanding of the roles that ICTs play in mediating these relationships will help to clarify expectations of what can be achieved.

Formal Drivers and Objectives for ICT Usage

A key premise of the AfricaAdapt network is that knowledge on climate change adaptation is often poorly documented and rarely shared in forms that are accessible to those who need it the most, whilst recognising that other forms of marginalisation linked to power, literacy and language play a significant role in peoples' access to this knowledge (Harvey et al. 2009). Meanwhile, at the international scale, ever-increasing flows of adaptation financing and policy guidance are being mobilised, often without sufficiently drawing on how knowledge and practice are unfolding at local scales. The network was therefore established to help address the gap between locally and internationally generated knowledge on responding to climate impacts in Africa, and the challenges faced by communities and governments in acting on climate change.

The network's operating principles involve:

- being demand responsive in how it selects and translates adaptation information;
- building alliances and partnerships that maximise the benefits of knowledge sharing and promote visibility with diverse stakeholders;
- addressing capacity constraints to knowledge access, sharing and use; and
- demonstrating the added value of a culture of knowledge sharing.

Accordingly, the AfricaAdapt partnership was designed to span geographic, discipline, linguistic and institutional divides that delimit this challenge. In practice this involved assembling a team with diverse expertise (science, agriculture, community-based adaptation, disaster management) from a range of stakeholders (NGO, intergovernmental, academic), and a range of locales (East and West Africa, Europe) with capacity to operate in English and French.

Stakeholders

AfricaAdapt's broader stakeholder group consists of a wide range of actors working on climate change adaptation on the continent, including researchers, community-based organisations, the media, policy makers and others, with the intention of promoting connections between these groups and increasing the access of those traditionally excluded from adaptation dialogues. For the purposes of this case, however, the key stakeholders consisted of the "management group" of 8-10 representatives from the partner organisations listed above (2-3 representatives from each partner, primarily consisting of the KSO and a management representative, most commonly the KSO's line manager).

Impact: Cost and Benefits

As the lead partner in the first phase of the network's activities, IDS played a significant role in selecting and ultimately enforcing the use of particular ICTs for coordination and sharing between the four network partner organisations. IDS brought an enthusiasm for new and sometimes unfamiliar tools to the partnership and due to its influence saw many of these ideas adopted. However, these were not always smoothly and unanimously appropriated by partners, who each brought different sets of expectations, experience, and constraints that ultimately influenced the informal negotiation of what technologies would be used, and how. These experiences reveal the close link between technologies and power relations in shaping partnership in line with the ways of working of the lead organisation.

Two examples that can be compared to reveal these influences are the use of Skype and of wikis within the management partnership.

In terms of selecting appropriate tools, the use of Skype as the primary means of communication was widely accepted by partners and was seen as an easy, low-cost alternative to telephone calls or extended email discussions. However, due to bandwidth constraints, and for ease of record-keeping, group discussions were primarily text-based. These text-based Skype meetings were chaired by IDS as the lead partner through a process that usually involved partners pre-drafting particular statements to others, negotiating agreement on contentious issues such as the distribution of responsibilities between partners via parallel one-to-one discussions using the same technology, and the use of varying degrees of directiveness and tone to control the pace of discussions and achieve particular outcomes. While many of these strategies are common within all meeting facilitation, the use of text-based Skype enabled their deployment (such as talking "behind the scenes" to secure support for certain decisions), potentially subverting the transparency of decision-making processes. At the same time, text-based Skype meetings facilitated some disengagement with elements of the discussion by participants simply not contributing, or by physically stepping away from their computers while the meetings were in process.

In contrast to the example of Skype, attempts to use wikis within the partnership demonstrate the ways in which partners actively and passively resisted the adoption or principles of use of particular ICTs. An attempt to implement the use of a wiki among managing partners to improve tracking and sharing of documents was resisted by partners who did not see the value of imposing another layer of navigation to access documents or who found it onerous to access another new, unfamiliar tool. Meanwhile, a wiki developed for KSOs to enable sharing of resources for implementing activities and minutes from meetings was used regularly for these purposes, but itself became a source of debate. While KSOs from the four partners and their capacity support team sought to keep this as a private space where they could discuss work together away from the scrutiny of their line managers, others within the partnership felt that creating closed spaces within the partnership was anti-collegial. Eventually it was agreed that KSOs would retain this online space, but would report back to the broader group on their discussions to ensure a spirit of openness. This debate highlighted the risk of selecting tools that meet the needs of some people within the network while being seen as inappropriate or insufficient by others, and how the use of particular tools can affect the cohesion of a network.

These two examples illustrate how the selection and deployment of ICTs impacted the relationship between the network's partners, while the norms of openness, participation, institutional hierarchy and connectivity across partners impacted the successful deployment of ICTs. They highlight how ICTs can provide benefits, but also potentially bear great costs on the strength of a partnership depending on how strategically and appropriately they are brought into action. As we will discuss below, this suggests the need for heterogeneous ICT-enabled partnerships (such as those often found in work on climate change and development) to reflect collectively on how these dynamic interactions impact desired outcomes of their work and ultimately influence the adaptive capacity of organisations and the clients of such networks.

AfricaAdapt, like many North-South partnerships, sits both within a context where access to, and mastery of new technology, is limited and variable, and among a range of other ICT-enabled climate change knowledge-sharing initiatives which tend to promote themselves on the basis of their use of sophisticated technologies. The challenge this presents was noted by one KSO:

People have this tendency of thinking that the latest or most modern tools are most effective and then they don't want to use older tools like the fax or the telephone, but those [tools] work. […] We need to rethink our definitions of ICTs, it's not about the latest tools, it's about the tools people use and that work. [trans.] (cited in Harvey 2011)

A further consideration in this regard is where the added value of particular technologies is likely to be experienced. For example, heavy investment of partners' time, finances and energy into technologies which are primarily aimed at enhancing transparency and accountability to donors, but have little impact at the level of service delivery to the network's primary stakeholders (e.g. researchers, community-based organisations and policy makers in Africa) may be attractive at some levels, but ultimately detracts from the network's activities and its ability to support adaptation actions and enhance adaptive capacity.

A final impact which appears to be emerging from the network's experiences with using ICTs in its first phase is the transfer of experiences and lessons learned from their use in internal management processes, to their selection and deployment among network members. As the network moves toward its second phase, partners are reviewing the suite of tools used for engagement with network members, and many which are now being added are either tools which have functioned well within the managing partnership (such as Skype) or whose absence in the managing partnership was noted (such as a mailing list or discussion group). Not surprisingly, wikis were never suggested as a new tool to deploy with the network membership.

In this regard, ICTs have played an important role in facilitating learning processes between managing partners, allowing rapid feedback and propagation of new ideas. One such example involved reflections from KSOs that the externally-facing ICTs used to engage the network's members were not achieving the depth of discussion and breadth of participation required to share learning and knowledge of often complex adaptation solutions. The idea of initiating 'meet and greets' – opportunities for face-to-face gatherings of the network's members in a variety of geographic locations – evolved from a mix of using ICTs for rapid reflection and testing through visits of KSOs to each other's organisations. Such 'meet and greets' are now a key feature of the network, a signal of the move to balance online and offline interaction with and between the network's members, which has allowed more meaningful participation from those not able or willing to engage with the technologies offered by AfricaAdapt.

Evaluation: Failure or Success

Ultimately, the use of ICTs in both coordinating work within the AfricaAdapt partnership, and reaching out to its worldwide membership has proven effective enough to see the network grow into one of the largest of its kind and to secure funding for a second phase of activities, now being led by ENDA-TM in Senegal.

Beyond the smooth functioning of the network's management group, the ultimate measure of the success of ICTs is whether or not AfricaAdapt has strengthened people's capacity to adapt to the impacts of climate change in Africa. Through external evaluations and studies to collect "stories of change" the network has identified a strong body of evidence to demonstrate impacts in this regard. The cases range from using AfricaAdapt's web-based resources to produce rural radio broadcasting content on impacts in Kenya and Cameroon, to rebroadcasting short videos on malaria and climate change in villages in Cote d'Ivoire, and even applying learning on rainwater harvesting from another African initiative (found on the AfricaAdapt website) in 20 villages in Malawi. These examples point to cases of knowledge uptake which has resulted in new actions to confront the climate challenges facing Africa.

Enablers/Critical Success Factors

Figure 2: AfricaAdapt Learning Review

One of the key factors in assuring this success amid the challenges described above has been the network partners' willingness to experiment and learn: to regularly review existing approaches, document and learn from successes and failures, and adopt new approaches where existing ones are not satisfactory (see Figure 2). One of the key factors in assuring this success amid the challenges described above has been the network **partners' willingness to experiment and learn**: to regularly review existing approaches, document and learn from successes and failures, and adopt new approaches where existing ones are not satisfactory (see Figure 2). One of the key factors in assuring this success amid the challenges described above has been the network **partners' willingness to experiment and learn**: to regularly review existing approaches, document and learn from successes and failures, and adopt new approaches where existing ones are not satisfactory (see Figure 2). This suggests, we would argue, that the success of ICT-enabled initiatives depends less on the "out of the box" effectiveness of their tools than on the initiative's strengths in ***experiential (or "double-loop") learning, innovation, and reflective practice***. For example, this approach to practice prompted a full-scale review of the network's web platform and ICT deployment strategy for its members, and which has resulted in a redevelopment of the platform (now underway) and the reprioritisation of its use of ICTs. It is also the key driver of the network's ability to transfer learning from successful uses of technologies in the core partnership outward to the broader membership, such as the recent piloting of Dgroups in the core partnership to assess whether it should be used with other members.

Critically, as noted above, this approach to learning has also helped to clarify where the limits to using ICTs within the core partnership and with the network membership lie, making evident where the need for face-to-face engagement and outreach using more traditional media are required and resulting in strategic changes.

Constraints/Challenges

A challenge that is closely related to the above has been **funding for ICT sustainability:** ensuring that there are financial resources available to continue evolving the network's engagement with ICTs in line with the lessons it learns. Budgeting for use of ICTs in funded projects tends to privilege set-up and maintenance costs, leaving scarce resources for ongoing re-development as user needs evolve, or lessons emerge that demand new ways of working. Consequently there is enormous pressure on partners to get everything right the first time, which can be unrealistic for new and rapidly evolving fields such as knowledge sharing on climate change adaptation. This can lead to networks being "locked in" to inadequate or inappropriate tools, as experienced by AfricaAdapt in relation to its online platform which could not be redeveloped until new resources became available. However, AfricaAdapt has tended to use many free or low-cost technologies, such as Skype, YouTube, Delicious or wikis, which have allowed a degree of flexibility irrespective of budgetary constraints.

Another challenge to both implementing and assessing the success of ICTs within heterogeneous partnerships such as this one is **norming success criteria**: establishing a common set of expectations against which to measure success. In the case of AfricaAdapt, for example, certain partners felt the availability of relevant information and data should be a priority, while for others platforms for effective dialogue between partners was a greater priority. Similarly, some felt that the network should develop the capacity to deliver all elements of the network's activities within the partnership (e.g. using desktop publishing, video editing, and even web development tools), while others supported the view that outsourcing aspects of the work was a more effective use of resources and would produce a better end product.

Recommendations/Lessons Learned

1) Select ICTs thoughtfully. ICTs are not an invisible mediator: they shape the outcome of climate change-related activities. AfricaAdapt's use of ICTs as a management tool by heterogeneous partner organisations highlights the need for collaborators to think hard about their choice of technology and the impact this has on their desired outcomes. The link between institutional practices, working cultures and expectations must be considered at the start of the partnership and frequently throughout to review whether use of technologies is creating positive and/or negative shifts in the ability to achieve impact.

We have learned that this reflection process can have significant bearing on the how ICT budgets are structured, what kinds of capacity support should be offered to partners, and importantly, on how to balance the adoption of new technologies with reliance on established forms of practice. It may also influence the transfer of practices from within the management process into the broader network membership and ultimately shape the network's objectives.

2) Look at stakeholders' own ability to learn and adapt. Organisations involved with climate change adaptation must themselves be able to adapt. AfricaAdapt experience suggests, we argue, that a key factor in the successful selection and deployment of ICTs within partnerships working on climate change (and other complex and highly uncertain challenges) is the adaptive capacity of the partnerships themselves. Learning from change, organising and building knowledge across systems and scales, and nurturing diversity are seen as essential components of this capacity (Folke et al. 2005).

At the same time, ICTs can potentially contribute to this adaptive capacity by helping these partnerships document learning, maintain and contribute shared stores of knowledge across distances, and by creating spaces for the contribution of a wider range of viewpoints and contributions than might otherwise have been possible.

As such, there seems to be potential for a mutually-reinforcing link between the effective deployment of ICTs for knowledge sharing, an ongoing commitment to learning in practice, and the strengthening of a partnership's adaptive capacity in the face of fast-evolving fields such as climate change adaptation (see Figure 3). One question this raises, which warrants further investigation, is whether, and under what conditions this link brings about a positive influence on the adaptive practices of the broader network membership.

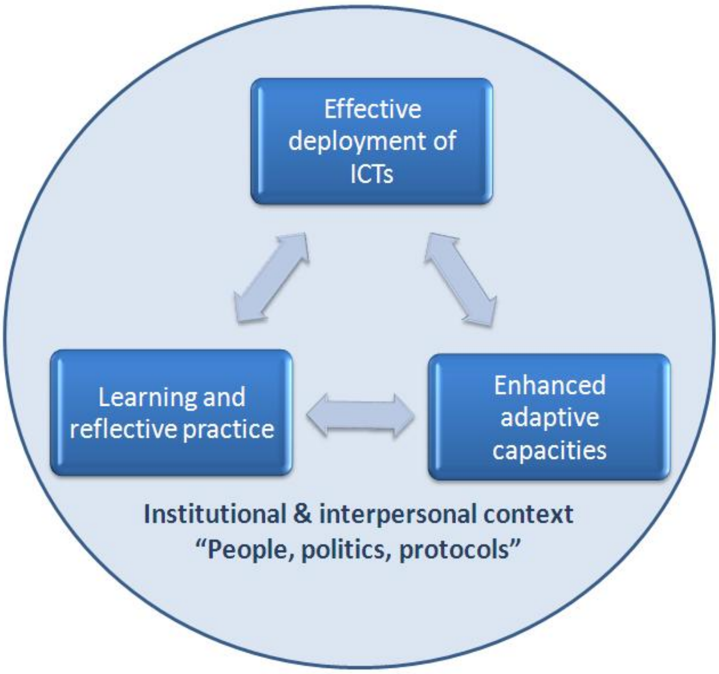

Figure 3: Relation between Technology, Learning and Adaptive Capacity

As stated above, however, these processes always unfold within a given context which is shaped by institutional and interpersonal norms, hierarchies, power relations, financial and time constraints, competing priorities, etc. and which will ultimately influence what can reasonably be expected and achieved.

Data Sources & Further Information

The authors, Blane Harvey and Tom Mitchell were both members and Programme Managers of the AfricaAdapt Network while based at the Institute of Development Studies. The observations in this case study draw upon their experiences in establishing and implementing the first phase of the network from 2008-2011.

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Part C: Case Studies of *ICTs and Agricultural Adaptation to Climate Change*

C1. e-Arik: Using ICTs to Facilitate "Climate-Smart Agriculture" among Tribal Farmers of North-East India

Author: R. Saravanan

Initiative Overview

The *Adi* tribal community inhabit the Siang river valley and foothills of the Eastern Himalayas of North-East India. Most farmers are smallholders, and practice *jhum* (slash-and-burn) cultivation. Together with difficult mountainous terrain, regular natural calamities, irregular monsoon rainfall, etc., this means agriculture is only for subsistence. 40 per cent of the population lives below the poverty line, and agricultural productivity has been among the lowest in India (MoRD-GoI, 2005). Within such an environment, climate change can readily tip the balance between security and insecurity. Meanwhile the slash-and-burn practices cause significant deforestation, and exacerbate the impact of climate events, for example by increasing the likelihood of landslides.

A 2007 information needs assessment found the overwhelming majority of *Adi* farmers lacked access to agricultural information with which to address these and other challenges such as pest and disease management. Four-fifths of the population possessed a radio, and nearly one-third of farmers had a TV and a fixed phone line. Very few possessed mobile phones, and none had computer and internet access; with only a very few of the more highly-educated community members even having ever used the internet (Saravanan 2007). More than half of the households (56 per cent) were not connected with electricity.

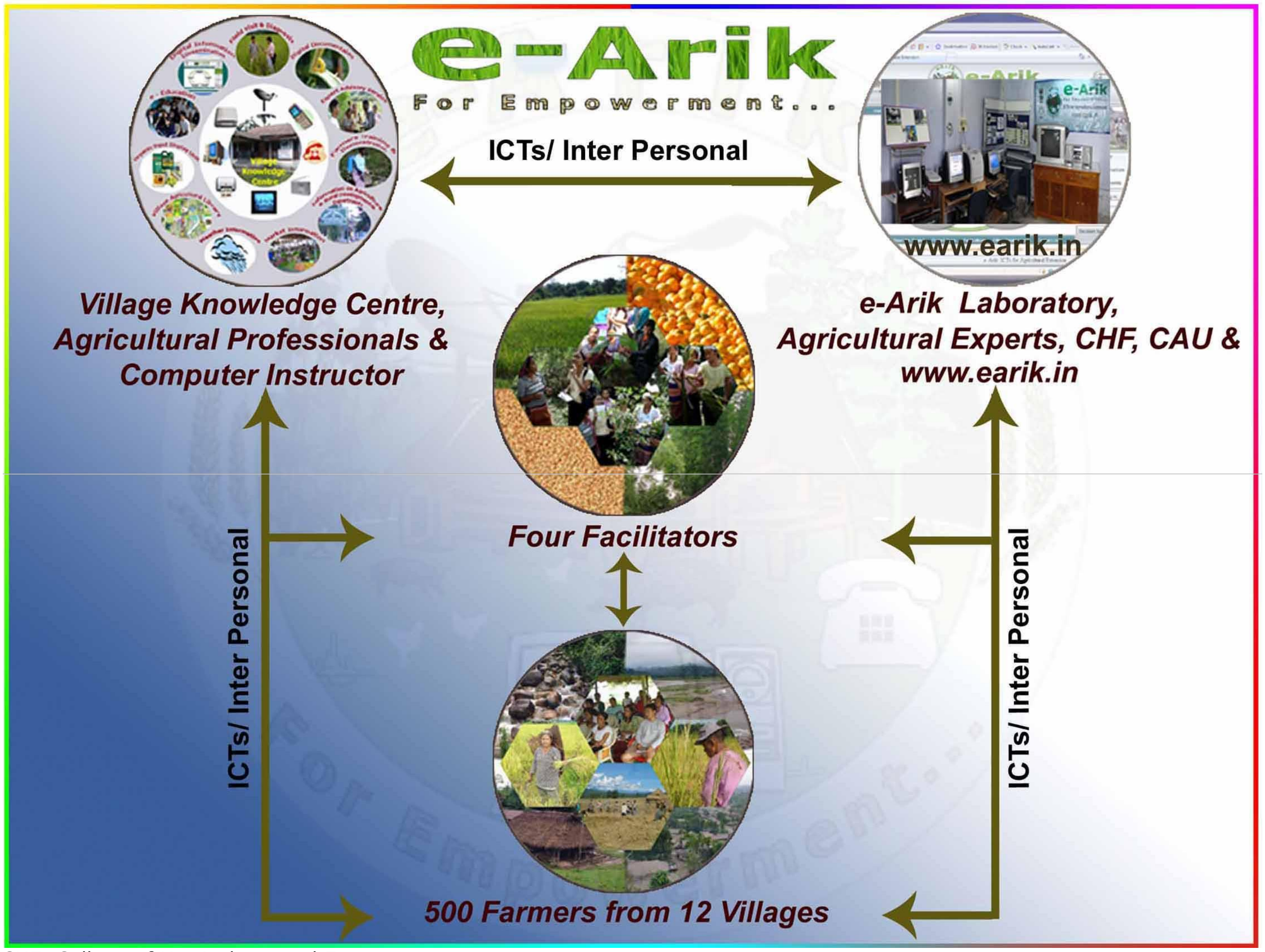
Considering this very difficult scenario, the *e-Arik* (e-agriculture) project was initiated in 2007, aiming to disseminate "climate-smart agriculture practices" and also to achieve food security. Climate-smart farm practices were seen as those that were sustainable, low input and reliant on organic technologies; and focus was on the two major crops of the project area: paddy rice (*Oriza sativa*) and Khasi mandarin oranges (*Citrus reticulata*).

Application Description

The e-Arik project established a 'Village Knowledge Centre' with computer, internet link, printer, scanner, phone and TV at Yagrung village. Project facilitators (agricultural professionals, a computer instructor and farmer-facilitators) were appointed at the Centre to help farmers access ICT-based agricultural information. A project portal (www.earik.in) was also created, providing:

- information on crop cultivation and other agricultural practices;
- baseline information from relevant agriculture and rural developmental departments of government (including information on objectives, priority areas, and administrative and technical personnel details and contacts for the departments of Agriculture, Horticulture, Fisheries, Animal Husbandry and Veterinary, Dairy, and the District Rural Developmental Agency);
- specific information on government schemes such as farmer welfare programmes; and
- day-to-day market information and weather forecasts.

Farmers could obtain information direct (e.g. from the portal and other websites, or from offline CDs) but would more often work via the facilitator intermediaries to access ICT-based information or to engage in remote consultation with other agricultural experts (see Figure 1).



CHF: College of Horticulture and Forestry
CAU: Central Agricultural University
ICTs: e-Mail, Fixed Phone/ Mobile
Interpersonal: Farmer-facilitators, computer instructor, agricultural experts

Figure 1: e-Arik Overview

For example, the e-Arik project staff regularly undertook field visits to observe crop conditions and to diagnosis pests, diseases, nutrient deficiencies and physiological problems. They could then digitally document these issues using ICTs in the field (see Figure 2) and, via e-mail and webcam, communicate them to staff at the e-Arik Research Laboratory at the Central Agricultural University. Problems were analysed by the experts (who themselves sometimes also undertook field/advisory visits) and recommendations were passed on to the e-Arik Village Knowledge Centre by e-mail and then to the concerned farmers by phone or personal face-to-face communication by the farmer-facilitators. Dissemination of information and good practice was also addressed by innovative approaches such as farmer-to-farmer communication and local self-help groups.

Figure 2: Facilitator Use of ICTs in the Field

Formal Drivers

Arunachal Pradesh State has rich biodiversity and unique ethnic groups, but also has a fragile and marginal geography characterised by predominantly hilly ecosystems, inaccessible terrain, and excessive sloping land (Saravanan 2006). The agriculture in the region is mainly at subsistence level, with food grain deficits being not uncommon. Add in a lack of irrigation facilities and a susceptibility to landslides, and it can be seen that this is an area that is highly climate-sensitive. The population depends heavily on the pattern of monsoon rains. Even slight deviations from normal weather patterns and normal climatic conditions have a disproportionately-damaging effect on those who live in Arunachal Pradesh. Yet such deviations appear to be increasing as a result of climate change.

Climate change should be recognised as just one factor among many that face these vulnerable rural communities, with the drivers behind the e-Arik project being the general state of agricultural insecurity, and the general lack of agricultural information.

Objectives/Purpose for ICT Usage

The e-Arik project aimed to provide better information about "climate-smart agriculture" in order to increase awareness of and capacity for climate-smart agricultural practices, ultimately leading to adoption of those practices. As defined by FAO (2010), climate-smart means agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation), and enhances achievement of national food security and development goals. This can cover a whole variety of actual practices on the ground – those being adapted to each particular context. Examples might include bunds and ridges for water retention, water conservation techniques, vermi-composting, and changing from shifting to settled cultivation patterns.

Stakeholders

The project stakeholders are summarised in Table 1.

No.	Stakeholders	Role
1.	Project sponsors from the Department of Scientific and Industrial Research (DSIR), Ministry of Science and Technology, Government of India	Providing financial resource, overall review and monitoring of project
2.	Project Team (Central Agricultural University)	
a.	Principal & Co-principal investigators	Overall day-to-day guidance and direction
b.	Project fellow	ICT specialist: designing multimedia CDs and project publications, uploading market information to the e-Arik web portal
c.	Research fellows (agricultural professionals)	Field advisory by ICT/ personal face-to-face communication
d.	Computer instructor	Project intermediary at e-Arik Village Knowledge Centre
e.	Farmer-facilitators	Field visits, digital documentation, local communicators
3.	Experts (faculty & scientists from the University)	Expert advice via ICTs and field visits
4.	Subject matter specialists of *Krishi Vigyan Kendra* (Farm Science Centre)	Project partners
5.	Village Tribal Council members	Project Advisory Committee members
6.	500 registered farmers from 12 remote tribal villages	Project beneficiaries

Table 1: e-Arik Project Stakeholders

Impact: Cost and Benefits

The e-Arik project incurred costs of Rs.245,000 (US$4,963) for the purchase of ICT, Rs.300,000 (US$6,077) for the project team's local travel (mainly vehicle hire charges), Rs.400,000 (US$8,103) for personnel (all project team members listed under Item 2 in Table 1) and Rs.81,000 (US$1,640) for other costs (e.g. consumables and contingencies). From 2007 to 2011 (the project was initially approved for two years, but it was extended for a further two years), the total cost incurred by the e-Arik project was therefore Rs.1.26m (US$20,783).

The main – as intended – impact has been the adoption of climate-smart agricultural practices. 44 per cent and 92 per cent of farmers implemented the information they had received via e-Arik on climate-smart farm practices on rice and mandarin crops respectively (Drishti 2011). Two years after project initiation, 55 per cent of farmers had developed new khasi mandarin orchards in their *jhum* field, which means they are permanently moving from slash-and-burn to settled cultivation. 42 per cent and 29 per cent of e-Arik beneficiaries reported increased production of rice and khasi mandarin crops, respectively.

Among the 500 e-Arik beneficiaries, an average income increase per farmer per season was reported of Rs.1,689 (US$37.50) and Rs.5,251 (US$117) for rice and mandarin respectively. An estimate can also be made that each farmer is saving – on average – Rs.2,400 (US$53) per year in fuel costs due to journeys to the agricultural extension office that would previously have had to be made, but which can now be foregone. Overall, it is estimated that the e-Arik approach is 3.6 times cheaper than a conventional agricultural extension system; that farmers can get access to information and services 16 times more quickly, and that is requires one-third of the time to then deliver the information and services (Saravanan 2008a).

Not all the ideas introduced by e-Arik have been a success. For example, a low methane-emitting and water-conserving technology – the System of Rice Intensification (SRI) – was introduced. Among forty trained farmers only two had adopted SRI by 2010. It may take a few more years to convince more farmers to adopt this, because it requires an entirely different farm practice compared to their usual cultivation method followed over the generations.

Evaluation: Failure or Success

The project was successful in demonstrating application of ICTs in promoting climate-smart agriculture practices; new approaches to farming that require few external inputs and which are organic. Such projects must necessarily be driven by the needs and interests of the farmer beneficiaries. For them, climate is an important issue, and they recognise signs of climate change. However, their overriding priority – and the main aspect that will contribute to their resilience in the face of climate change – is increased incomes. This has therefore been the main initial focus for the project; a focus – given the growth in average incomes and the journey/fuel cost savings – in which it can claim success. ICTs are only one part of the socio-technical package that has consisted of greater intervention from agricultural facilitators and experts. But that package would – if given ongoing funding – be sustainable, and able to address more climate change-specific issues as and when they arise in future.

As noted, the project was initially funded for two years, and then for a further two years, up to 2011. At the time of writing, a second-phase scale-up of the project is planned with further government funding, greater emphasis on use of mobile phones, and the intention to replicate the same model in India's seven other north-east States.

Enablers /Critical Success Factors

The following were identified as critical factors that have enabled the e-Arik project to be successful:

- **Utilising trusted local intermediaries**: A key challenge for projects seeking to support agricultural adaptation is the gap between external agricultural experts and the local farmers. These are gaps of knowledge, culture and – in this case – language with farmers speaking the *Adi* tribal dialect. The key to bridging that gap was the selection of educated young farmers to act as intermediaries under various terminologies including "farmer-facilitators", "local knowledge managers" and "para-extension professionals". The young people were able to record field conditions using digital cameras and camera-enabled phones (see Figure 3); were able to make use of ICTs in the Village Knowledge Centre to send and receive information; were able to communicate with the agricultural experts; and could act as trusted and credible channels by which information could be communicated to the other farmers, hence forming a farmer-to-farmer communication model.

Figure 3: Using Mobile Phones to Collect Field Data

- **Appropriate use of different – including non-digital – ICTs**: The e-Arik project had at its disposal a wide variety of different ICTs, and made use of them in different ways. Thus mobile technologies were used to record from the field. Radio and TV were used as a channel for general awareness-raising about climate and agricultural issues but not for specific guidance. Video was used – sometimes shown via laptop actually in the field – in order to communicate specific details of adopting new agricultural technologies. Physical publications were used – forming a village library – for use when power outages prevented ICTs from being used. Finally, physical display of organic farm inputs at the Village Knowledge Centre was used as a means to stimulate interest and awareness (with 90 per cent of visitors recorded as having enquired about availability of the inputs shown).

- **Multi-channel message reinforcement including face-to-face**: As can be seen from the previous item, e-Arik did not rely on a single channel in order to communicate. Where conventional agricultural extension may use just human communication, and some e-agriculture projects use just ICTs, e-Arik used both people and multiple ICTs. Thus awareness-raising occurred through farmer-facilitators and radio and TV. And demonstrations of new agricultural technologies were undertaken by visiting agricultural experts and through video. This multi-channel approach increased the scope and depth of communication, and – through reinforcement – helped ensure that messages were received and were turned into actions.

- **Multi-stakeholder partnership**: Although there are costs to setting up a project with multiple partners, there are also significant benefits. Partnership with community members as Advisory Committee members and as intermediaries was central to the acceptance of the project. Partnership with a broad range of other agricultural advisory service providers – mainly the various government departments and the Farm Science Centre – ensured support for the project, and gave access to all necessary expertise. Thus, for example, expertise on indigenous pest and disease management was only available via subject matter specialists at the Farm Science Centre; and their expertise was readily channelled to the Village Knowledge Centre and, from there, via the farmer-facilitators to the farmers.

Constraints/Challenges

Challenges faced by the project included:

- **Technological and human challenges of working in remote, rural areas**: Climate change especially affects rural, upland areas, but intervening with ICTs in such locations has specific challenges. Technologically, there were frequent power and communication cuts, thus making it impossible to provide continuous ICT-based information services, and requiring an escalating series of back-up options from offline CDs through hard copy to human facilitators. Even the human side had its difficulties with landslides and flooding during the rainy season making travel difficult or impracticable; and with the dominance of the local language making it impossible for outsiders – such as visiting agricultural professionals – to communicate direct with farmers.

- **The need to create climate-appropriate information from scratch**: While traditional agricultural information – whether from local or external scientific sources – is fairly readily available, this was not always the case with climate-smart agricultural information; i.e. information on practices of particular relevance to climate change adaptation, or on practices that were low-carbon-footprint and sustainable. Therefore, that information had to be created through a combination of external research and local, iterative piloting.

- **Digital scepticism**: While some of the core project team were familiar with ICTs, this was not the case with many of the more senior officials from both the implementing organisation, and also from governmental agricultural and rural development departments. As a result, they were unaware of the role of ICTs in both agricultural development generally and climate-smart agricultural practice specifically. Reactions ranged from naivety and incomprehension through to scepticism and a lack of willingness to co-operate.

- **Demand for total development assistance**: The project was offering assistance in a specific and delimited area: climate-smart agriculture. But the farmers – seeing this as the main government-supported assistance project interacting with them – saw no such boundary lines. They wanted the project to help with other problems, such as fencing to protect from animal intrusion, and marketing to improve product sales. This caused problems at the start, in convincing the farmers about the value of the project, and causing ongoing tensions between narrower project priorities and wider farmer problems.

- **Project scepticism**: The farmers' conflation of the project with typical government rural development programmes was also problematic because this raised negative connotations. The farmers associated such programmes with the siphoning-off of project funds by officials for their own personal use. It was difficult to help some farmers understand how e-Arik was different and, as such, they were reluctant to engage with the project; at least initially.

- **Problems of financial sustainability**: In the beginning, the e-Arik project was only funded for two years, and sustaining project activities after this period looked to be very difficult. Farmers were surveyed to find their willingness to pay for the type of service provided. In large part due to the scepticisms and/or demand for total assistance noted above, 34 per cent were not willing to pay at all, and 52 per cent were only willing to pay Rs.50 (US$1) per crop season – not by any means enough to sustain the project financially (Saravanan 2008b). This also related to the farmers' perception that agricultural advisory services are part of the welfare activities of the state, and thus should be provided free of charge. As a result – and in recognition of the value of the project – it was given the additional funding already described.

Recommendations/Lessons Learned

- **Climate change adaptation projects can legitimately target income generation**: Wealth is recognised as a key component of climate change adaptive capacity; perhaps the single most important component (Brown et al. 2007). It is therefore appropriate for e-agricultural adaptation projects to focus on raising rural incomes. This will help build adaptive capacity.

- **Make use of local knowledge for climate change adaptation**: It could be observed within this project that many of the tribal farmers were already undertaking climate-smart practices such as those to counteract pests and diseases. Thus local innovations that were relevant to climate change were already in existence; what was needed was to digitally document those practices and then disseminate them to other farmers via the power of ICTs.

- **Prioritise appropriate ICTs**: For these remote rural areas, the web and internet are, as yet, rather "foreign" technologies that the farmers themselves are largely unfamiliar with. ICT design for e-agricultural adaptation projects should therefore focus on those ICTs that are already in use. This would include radio and TV for general awareness-raising, and mobile phones for more individualised assistance. Farmers also seemed quite comfortable with participatory video as a technique.

- **To convince farmers, show and tell**: ICT-based information alone – i.e. just telling farmers – was typically not enough to get them to change their practices; even if that information was delivered via local farmer-facilitators. What was also needed was a demonstration within farmers' fields. For example, the use of bio-fertiliser-based seed treatments required some innovative local farmers to adopt the practice, and for other farmers to then see it working. Similarly, text-based information about new practices was much less effective than digital videos showing a demonstration by other local farmers.

- **Provide not just agricultural practice information but a complete resource package across the agricultural supply chain**: Climate-smart agricultural projects will not be effective if they only focus on providing information about agricultural practice. Provision needs to be more holistic in two ways (see Figure 4). First, the project must find a way to deliver all the resources necessary to turn information into agricultural action. This means the provision of money, labour, technology, motivation, and support. Even if not directly delivered by the project, these resources must be available or the information will remain unused. Second, the project must work across the supply chain: not just focused on agricultural processes but on backward linkages to inputs (farm machinery, fertiliser, seeds) and on forward linkages to outputs (post-harvest technologies, and agricultural markets).

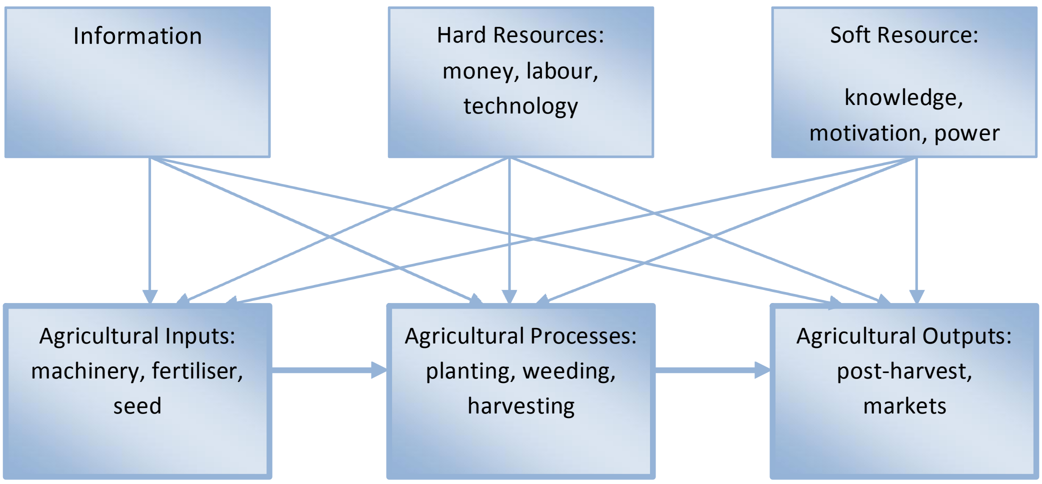


Figure 4: Holistic Provision on e-Agricultural Adaptation Projects

Data Sources & Further Information

This case study is based on published information (available at www.earik.in) and also the personal observations of the author, who was Principal Investigator of the project. Some of the videos produced for the project can be found at: http://www.youtube.com/user/eArik2007

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C2. An ICT-Based Community Plant Clinic for Climate-Resilient Agricultural Practices in Bangladesh

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Initiative Overview

The south-west coastal region of Bangladesh is particularly climate-vulnerable; impacted both by immediate climate events and by longer-term climate change. Crops and horticultural production are being hampered due to changing seasons, erratic rainfall, rising temperature, unpredictable fog, and coastal flooding and increasing salinity due to rising sea levels and cyclone/storm surges in the area. Moreover, new pests and insects are destroying crops. As a result, local farmers are demanding information about pest control, new saline-tolerant varieties, improved agricultural management practices, early warning of weather events, etc.

Local NGO, Shushilan, responded to these climate challenges by developing two ICT-based plant clinics in the sub-district of Kaligonj (part of Satkhira district). So-called "plant doctors" – that is, local agricultural extension workers employed by Shushilan – use ICTs in order to assist farmers; providing the farmers with the information they require. ICTs can also be used by the plant doctors to share experiences between farmers, and to pass on early warnings on floods and cyclones that are generated by the Bangladesh Meteorology Department, mainly via mobile phone. In addition, Shushilan has set up an Agriculture Research Centre, soil-testing laboratory, demonstrator farms, and seed storage facilities in order to provide holistic support to the c.4,000 farmers who fall within the project's purview.

Application Description

As detailed below, Shushilan has been using a variety of different ICTs in its plant clinic project:

***Mobile phones*:** Mobiles are widely available in rural Bangladesh; for example via Grameen Phone and Banglalink. If farmers face any plant-related problems, they can call and either speak to one of the plant doctors direct, or leave their query with the plant clinic. Examples of calls would include fairly specific questions about attack by unknown pests, about seed quality, about pesticide or fertiliser dosage, or about how much to irrigate. Typically, the plant doctors are able to give immediate responses via phone. However, sometimes, they must in turn contact agricultural experts to get their advice which they can then pass on to the farmers. Occasionally, they put farmers in touch with other farmers whom they know have faced and dealt with similar issues via the clinic service.

Computers and Internet: The plant doctors themselves make use of laptops for field visits. They keep records of the calls they receive and also the field visits they undertake using standard MS Office software. In this they record farmer details and location, date, and problems and solutions. They also utilise software from the *Pallitathya* project as a Q&A database on which they store similar details. They can interrogate this subsequently to see if later problems have already been recorded against possible solutions. This could, in time, form a database of agricultural and adaptive practices for wider dissemination and use. As noted above, if the plant doctors cannot themselves address a problem they will contact agricultural scientists – either by phone or email – for example from the Bangladesh Rice Research Institute (BRRI) and Bangladesh Agricultural Research Institute (BARI). More complex queries will involve emailing notes and photographs (see next). On this basis the scientists will seek to provide solutions – typically around issues of pest/disease management, treatment of salinity, and shifts to low-input agriculture. Sometimes, during plant doctor field visits, the farmers are put into direct contact with scientists via phone or webcam, to enable the latter to directly understand – and see – the field issue being faced (see Figure 1). Finally, plant doctors make use of a geographic information system (Arcview) and Google Earth to identify exact farmer locations, and to map this against known climate and climate change vulnerabilities.

Figure 1: Farmer Talking with Remote Agricultural Scientist via Mobile Phone

***Digital cameras and microscope*:** When they visit farmers, the plant doctors take along a digital camera. They use this to take photographs – of pests, of diseased plants, of weeds, of water levels, of soil condition, etc. They also use the cameras to make video recordings of these problems and of the farmers talking about the problems. The project also has a digital microscope through which photos or video of pests and microorganisms can be recorded. Once edited, these photographs and videos can be sent via the Internet to the remote agricultural scientists (see Figure 2). The scientists use these to provide information and advice to the farmers, and also as the basis for their own research work. The videos can also be used (see next) for farmer multimedia presentations.

Figure 2: Plant Doctor Interacting with Remote Agricultural Scientist via internet, Using Microscope Images

***Multimedia*:** As well as being solution providers, the plant doctors have a more general educational role. For this purpose they have made use of video presentations, particularly video made within the local farming communities. This is particularly seen as a tool for agricultural technology transfer; for example around management of new pests and diseases, introducing saline-tolerant crops, applying fertiliser appropriately, crop diversification or intensification, and increasing crop productivity.

Formal Drivers

The agro-ecology of the south-west coastal region of Bangladesh is very fragile, and has suffered adverse impacts due to climate change. Within the last ten years, many farmers in Satkhira district have migrated away due to loss of agricultural land and crops because of increased salinity. Land erosion and rising salinity – measured by Shushilan's clinic as having risen up to 15 to 25 parts-per-thousand (ppt) in the dry season, and up to 5 to 12 ppt in the wet season – are a direct result of climate change and resulting sea level rise. Plants that were healthy in the early stages of planting are seen to turn yellow in the vegetative and reproductive stages due to saline intrusion and also due to erratic temperature and rainfall, both of which can in part be related to climate change. In 2007, the rice crop failed significantly due to erratic weather – a long duration of fog and cold, plus attack from new pests and weeds. This area is therefore on the front line of climate change – for farmers in Satkhira, climate change is not a future possibility, it is a current lived reality that is damaging their livelihoods.

It is for this reason that Shushilan launched its plant clinic project. It had already piloted climate-resilient agricultural practices, such as the use of saline-tolerant rice varieties. However, a fuller agricultural information and support approach was required if these and other new technologies were to be rolled out across the district. Key gaps included lack of awareness and practical information about climate-resilient practices, general lack of modern agricultural practices and technologies, and a lack of effective linkages between scientists, extension workers, and farmers.

Climate change and associated weather pattern changes and extreme events have also driven changes to traditional cropping patterns and agricultural practices. Again, the farmers lacked information about how to react. For example, when monsoon rains have been delayed, farmers are unclear what they should do, and their lack of an agricultural support system that could provide answers was a further impetus to Shushilan's project.

Objectives/Purpose for ICT Usage

The overall aim of the project was:

- To identify causes, and provide solutions to common agricultural problems including those related to climate and climate change such as new pests/diseases and rising salinity levels.
- To increase the usage of innovative agricultural technologies; specifically those such as saline-tolerant rice varieties that could address the rising salinity level which climate change was causing.
- To improve agricultural productivity generally through more appropriate use of fertiliser, pesticide/herbicide, and modern agricultural practices including crop intensification and diversification.
- To develop a strong network of linkages between agricultural scientists, extension workers (plant doctors) and farmers.

The role of ICTs was to support achievement of all four objectives, enabling the capture, processing, storage and dissemination of information that would support climate-resilient agriculture.

Stakeholders

As already outlined, there are three main levels of stakeholder. At the field level are the coastal area farmers. They are the main beneficiaries, who are seeking to maintain or increase their agricultural production in the face of climate change and other challenges. Centrally, there are research scientists in the rice and agricultural research institutes, and also officials of the Department of Agricultural Extension. Sitting between these two groups are Shushilan; in particular the two plant doctors who provide farmers with as much support as they can in terms of education, diagnosis and prescription, but who also connect with the scientists when need be (see Figure 3).

Figure 3: Plant Doctor with Farmer Diagnosing Vegetable Crop Problems

Impact: Cost and Benefits

The primary investment to establish the two plant health clinics was around US$6,000 to pay for two computers, two webcams, two digital cameras, two mobile phones, one digital microscope (shared by the two clinics) and two motorcycles. In addition, there is a recurrent cost for the two plant doctors' salaries, house rental, transportation, and fuel and utility bills (including internet connectivity charges). This amounts to around US$1,500 per month.

It was the initial intention that the farmers would be charged for the services being provided e.g. around US$0.10 for service provided via a mobile or the Internet. However, given the low level of community awareness about ICTs and the need to demonstrate the value of the plant clinic service, it was decided to offer it for free in the first instance.

The farmers do seem to perceive a value from the service, with group discussions showing that farmers rated positively both the suggestions they have been receiving via the ICT system (such as suggestions about tests to conduct on their crops; about planting saline-tolerant crops; about cultivating different crops such as maize or sunflower), and the prescriptions they have received (i.e. specific guidance on fertilisers or pesticides: which to choose and how much, when and where to apply them). It is therefore anticipated that in future, farmers will be willing to make a small payment for the plant clinic services.

The plant doctors themselves were also able to report project benefits. For example, one of them was asked to identify a new and unknown disease in part of an eggplant crop. He uploaded digital images and sent them to the Global Plant Clinic (GPC). The disease was diagnosed as *Tulshipora* (the local name), which was correlated with the warmer temperatures that area had been experiencing. Unfortunately the GPC's advice was that there was no effective treatment, and that the infected plants would have to be destroyed.

Evaluation: Failure or Success

Three years after inauguration of the clinic, a formal evaluation of the project was carried out. This was based on qualitative analysis through focus group discussions (resource constraints prevented a detailed quantitative cost/benefit analysis). As noted above, farmers reported positively on the value of suggestions and prescriptions received from the plant clinic. Farmers were also keen to receive the type of fast, good-quality information and advice which the plant clinic could deliver; particularly relating to pests/disease, new crop varieties, fertiliser/pesticide dosage, and early warning information. They expressed a willingness to pay something for this information, and certainly demand for the plant clinic's services has been continuously growing. The project overall was able to demonstrate good results from planting of saline-tolerant rice variety BR-47 (developed by BRRI) in two village areas where wet season saline levels rose up to 10 ppt (see Figure 4).

Although Shushilan itself was unable to conduct quantitative research, the local office of the Department of Agricultural Extension was. Its 2010 report for Kaligonj sub-district showed, for example, that the prescriptive information about treatment of pests and diseases has helped, with an estimate that the loss of production due to these causes had been reduced by at least 20% between 2007 and 2010, though the plant clinic is only a partial contributor to this outcome. Over the same period, crop productivity has also increased with the yield gap (the gap between the actual and the potential output level of crops per hectare) being reduced in 80% of cases. There has also been greater diversification of the crops planted (e.g. use of saline-tolerant rice and planting of maize and sunflowers), and a growth in crop intensification (the average number of crops planted per year) from 1.00 to 1.28.

Figure 4: Fully-Grown Saline-Tolerant Rice in Kaligonj Sub-District

Enablers/Critical Success Factors

The **plant doctors** themselves are vital to the success of the project. They are hired from within the local district, so they are familiar with the local context, and farmers are familiar with them. Both were unemployed prior to the project, but had completed an agricultural college diploma course, so they were familiar with ICTs and with overall agricultural science, issues and practices.

Availability of ICT infrastructure has been a key enabler of this project. Just a short time previously, mobile and internet coverage within Kaligonj sub-district were insufficient to have allowed a project like the plant clinic to have worked. Only once these were available did this project become feasible.

The digital microscope has been a valuable additional piece of specialised technology. While not quite bringing the facilities of an agricultural lab to the field, it has enabled this project to be the agricultural equivalent of telemedicine, delivering scientific results from within the community to distant agricultural experts and enabling them to diagnose problems and recommend solutions.

Constraints/Challenges

Competency deficits were a particular problem for the project, across the range of competencies – knowledge, skills, and attitudes. Farmers had low levels of awareness and even lower levels of skills in relation to ICTs; nor were they familiar with English, the working language of the majority of the software used. As a result, they were not positively disposed towards the idea of using ICTs for agricultural advice (leading, as seen above, to an initial unwillingness to pay); and when they did get involved, they had to rely entirely on the plant doctors in order to use the ICTs.

Other resource deficits that affected the project included power supply problems, meaning that ICTs could not be used continuously; and the limited number of plant doctors and related ICTs, as a result of which farmers could not always be availed of a quick service – this particularly being a problem when farmers faced immediate climate-related hazards. As noted previously, resource deficits also limited the extent of project monitoring and evaluation that Shushilan was able to undertake. This, in turn, has limited the ability to explore opportunities for wider replication of the project design.

Recommendations/Lessons Learned

The key lessons from the project are:

Agricultural climate change projects require designs that offer **on-site delivery of information and advice to farmers**. At least in the types of areas covered by this project, farmers have a lack of familiarity with ICTs such as computers and email and/or a lack of contacts or confidence through which to use mobile phones and other portable technologies. This will undoubtedly change over time as ICTs diffuse further into poor, rural areas. However, for the foreseeable future, adaptational projects focused on climate-resilient agriculture that use ICTs are going to need to be addressed largely via human intermediaries. This will increase the cost and/or reduce the scope and sustainability of such projects, but is necessary for agricultural practices and technologies to change.

A **more-than-mobiles approach is required**. The rapid diffusion of mobile phones within agricultural communities, and the growing familiarity of farmers with using mobiles has given hope for the idea of "m-agricultural adaptation" projects based around this technology. While – as noted in this project – mobiles can have an important role to play, their power is not yet sufficient. The digital camera, digital microscope, internet connections, laptops and GIS/databases were all a necessary part of capturing and transmitting the richness of data required to solve agricultural problems and/or to give guidance on new technologies such as saline-tolerant rice. Projects therefore need a full "ICT ecosystem" rather than relying on just a single digital technology.

Climate change and climate change adaptation information and advice must be available, accessible and usable. Farmers had a good sense of the problems that extreme climate events, variability and change were causing to their agricultural livelihoods. They were also provided – via the plant doctors and ICTs – with a means to get information and advice on this. However, many other elements need to be in place if the full information chain – from data through information and decisions to actions and results – is to be operationalised. Bangladesh has a good supply of traditional agricultural information, but it needs to develop more sources of information about climate change and particularly about how to adapt agriculture to climate change. Those working in the field – such as agricultural scientists and Shushilan's plant doctors – then need to be aware of these sources of information; at present they often are not. Then farmers must have a demand for, and receptivity to, this information. Again, at present they often do not, regarding climate change symptoms as natural *forces majeures* that they can do little or nothing to deal with. Finally, even if all these steps can be overcome, the farmers need to have ready access to the resources needed to take action – new seed types, materials for alternative irrigation arrangements, etc. Shushilan's relatively holistic approach did help meet the need for this final element.

Identify hybrids who bridge the digital and the agricultural, the external and the local. The plant doctors highlight a critical role that e-agricultural adaptation projects must fulfil: that of the intermediary or hybrid who combines and bridges between different worlds. In this case, the plant doctors perform this in a double way. They combine understanding of ICTs and of agricultural practices, including the impact of climate change on those practices. And they act as a bridge between the external, scientific knowledge of those working in the agricultural institutes, and the local knowledge of the farmers working in the fields.

Data Sources & Further Information

Data and information for this case study was collected from the Department of Agriculture Extension office at sub-district level, the Shushilan Agriculture Information Centre, the *Pallitathya Kendro* (village information centre), daily newspapers, discussions with plant doctors, and community consultation in different periods during implementation of the project.

The authors themselves all work for Shushilan and have been involved in the plant clinic project in various roles:

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C3. Using Radio to Improve Local Responses to Climate Variability: The Case of Alpaca Farmers in the Peruvian Andes

Author: Yezelia Caceres Cabana

Initiative Overview

Livelihoods in high mountain areas are precarious at the best of times, and made more so by climate vulnerability. This case study focuses on radio's contribution to sustainable mountain livelihoods in the Peruvian Andes.

Peru has the largest number of South American camelids (the animal group that includes llama, alpaca, vicuna and guanaco) in the world, with more than 5 million of the four species of which 3.6 million are alpaca; more than 85 per cent of the world's total (Fernandez et al 2008). Camelid rearing takes place all along the Andes at altitudes of 3,500-5,000m, where other forms of agriculture are uneconomic (see Figure 1). It is therefore key to the economic survival of those living high in the mountains, supporting more than 65,000 families in Andean Peru alone.

Figure 1: Alpaca Farming in the High Peruvian Andes

Alongside a more general warming that is slowly extending the range of arable land, and squeezing that available for alpaca farming, the more immediate problem for all farmers has been an increase in climate variability. In particular, there have been a set of unexpected cold snaps, with heavy snowfall, which have caused serious problems. These include water scarcity leading to a reduction in available pasture, and an increased death rate particularly of pregnant (up to 20 per cent dying) and young (more than 30 per cent dying) alpaca. With alpaca farming being the main income source, this loss of animals condemns further those who are already living in conditions of severe poverty.

Underlying these problems was a lack of adaptive capacity among the farmers; capacity that would enable them to take short-term actions to cope with sudden climate variations, and longer-term actions to improve the income they could derive from alpaca farming. To address this, the CAMELTEC project was initiated by Peruvian NGO Desco[1] with the financial support of Oxfam GB; running from 2008 to 2010. It was focused on the main alpaca-producing regions of Puno and Arequipa; most particularly on 31 communities of 1,725 families.

CAMELTEC was broad-ranging in its remit; aiming to address technological, social, political and institutional issues that affected these communities. There was a strong informational component based mainly around radio and offering meteorological warnings but also advice on husbandry to reduce the impact of climate variability on animal disease and death. Such advice was provided both in preparation for cold spells or other weather events, and during those events themselves. The project also addressed itself to factors such as markets and market pricing for alpaca wool, and the organisation of the alpaca farmers and the institutional support provided by local government and others.

Application Description

A key component of the CAMELTEC project was broadcast of the radio show *Amanecer Alpaquero* (Alpaca Farmer's Daybreak) starting in May 2008 and running until March 2010. The scheme bought radio time from two local stations[2] and produced a 20 minute show once a week. The programme could be received not only in the two selected districts of Puno and Arequipa but also in the neighbouring department of Cusco and in nearby areas in Bolivia (see Figure 2).

Figure 2: Map of Radio Broadcast Area

[1] *Centro de Estudios y Promocion del Desarrollo* – Centre for the Study and Promotion of Development
[2] In two zones: Radio Onda Azul for listeners from Puno and Radio San Antonio de Callalli for listeners from Arequipa.

Each show typically introduced a situation relevant to Alpaca farming, followed by a short recorded discussion among farmers with input from experts solving a particular problem. The show was popular with all members of Alpaca farming families not just because of the vital information provided, but also because of its use of humour and music in transmitting its message. Vitally, broadcasts were made not only in Spanish but also Quechua – one of the most important indigenous languages in a region where many living in remote communities have a poor command of Spanish. The broadcasts were also pertinent to the farming seasons, for example how to make hay during the seasons when pasture was mature, or a programme broadcast during the birthing season from January to March which focused on the importance of disinfecting the navel in offspring - a practice which alone can reduce mortality of new-born alpaca up to 30%.

Radio broadcasting is inexpensive with low set up and operating costs, including writing and production expenses. It requires little investment and as almost everybody has a radio, any programme can broadcast to many people dispersed over a wide area instantaneously. The availability of cheap battery-powered AM radios means that the majority of Alpaca farming households have access to local radio broadcasts. Farmers are also able to take radios with them to the field since reception coverage is close to universal (see Figure 3).

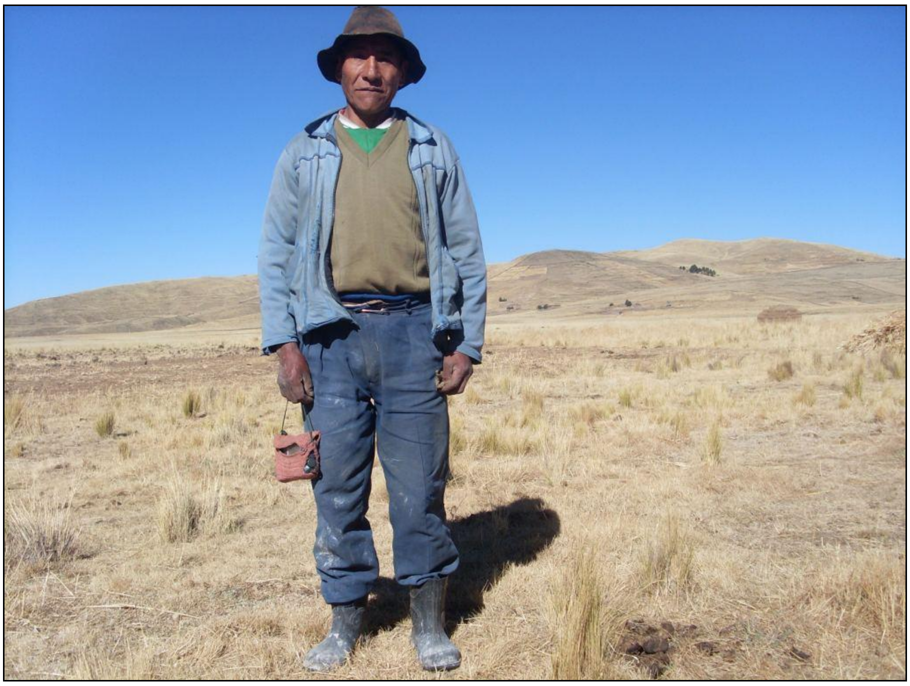

Figure 3: Alpaca Farmer with Radio

Formal Drivers

Climate variability in the Peruvian Andes seems to consist of three main effects:

- On the one hand, there has been a general warming associated, for example, with glacial retreat: a reduction of 22% in area in the past 35 years (MINAM 2010).
- On the other hand has been *friaje* (the freezing) defined as "an event characterised by low temperatures, a drastic reduction and abnormal average temperature, which is accompanied by snow" (FAO 2008). Associated with the meteorological phenomenon of a cut-off low, it corresponds in practice for the alpaca farmers with temperatures as low as minus 24°C and snow up to 50cm thick. Occurrences of snow, ice and hail storms have more generally been increasing; for example from 7 in 1995 to 531 in 2005 (INDECI 2006).

- Thirdly, water availability has declined due to changes in rainfall patterns with a decline in total annual rainfall and an increase in the number of consecutive dry days. Combined with the average rise in temperatures, this has led to predictions that "Andean deserts" will start to emerge in the regions above 3,800m (Huamani 2005).

For the alpaca farmers, the result has been a set of harsh cold spells that have killed livestock, reduced birth rates, introduced new diseases, and reduced productive yields of their herds. All of this has reduced incomes for those who are already living on a financial knife-edge.

Alpaca family homesteads are distantly located from each other, typically 10 km apart due to the amount of land needed for grazing. Both men and women take responsibility for raising livestock although increasingly this work is left to women as recent climate events have forced men to travel for at least four months per year to the valleys and cities, seeking employment in temporary infrastructure projects to improve their income. Meanwhile, the price of alpaca wool, the main commodity, has decreased due to a reduction in demand for products caused by the worldwide economic crisis.

There are short-term adaptive actions that the farmers must be made aware of and enabled to implement: building water storage facilities; planting grass and other fodder sources; building infrastructure to protect their livestock; monitoring disease. In the longer-term, too, farmers need to incorporate breeding programmes to improve the quality of their herds, including the yield of derivatives such as alpaca wool. If possible, the *alpaqueros* also need to try to move up the value chain since they gain relatively little from their wool. As an example, farmers receive an average of about US$2.50 per pound of wool; yet an alpaca scarf (which weighs much less than a pound) sells for US$30 on the local market and US$80 on the international market.

Obtaining information for awareness, advice and guidance is a first step for these adaptive actions. However, due to the Andean topography of high peaks and deep valleys, it has historically been cost-prohibitive to construct infrastructure such as paved roads, electricity and fixed telecommunications up to the farmsteads. There are some fixed telephony and Internet connections in the district capitals and main towns, but these do not reach to the villages and the farmers' homes. The only communication mechanisms for them are therefore wireless. Mobile phones do have their uses – and some 90% of alpaca farmers own or have access to a basic mobile. However, their utility is limited because the farmers' homes are not within the coverage area and so they have to travel to find a signal. It is thus radio that forms the sole reliable means of modern communication, and hence it was radio that was the technology selected for the CAMELTEC project.

Objectives/Purpose for ICT Usage

Overall, the CAMELTEC project aimed to use radio and other means to achieve three goals:

- Strengthen local organisations such as farmer co-operatives to enable the introduction of sustainable (including climate-sustainable) livestock practices
- Improve the quality and quantity of alpaca wool being produced, through good husbandry and reproductive management practices
- Improve income through changes to wool output and through better market access

Thus, some radio broadcasts had a specific aim of helping farmers cope with *friaje* through better water conservation, improved fodder growth and storage, construction of barns and sheds and corrals (see Figure 1 above), better animal husbandry and treatment of disease. But alongside this, CAMELTEC had much wider aims that sought to address the totality of the farmers' fragile livelihoods. This included working with officials of the farmer co-operatives and with staff in local government, and the training of selected (educated) individuals from within the communities with skills they could share with neighbouring farmers.

Stakeholders

As summarised in Figure 4, the main stakeholders in the initiative are alpaca farmers and their families. They have lives of subsistence and insecurity, with high poverty rates and housing that lacks water, electricity or heating. The CAMELTEC project was led by Desco, an NGO with 46 years of experience in promoting development in the Peruvian alpaca sector via improved socio-economic conditions. This project was Desco's first experience in using radio broadcasts with alpaca farmers, and necessitated a partnership with De Frequencia AM – a small local broadcasting organisation with very limited resources – and the two local broadcast stations. Oxfam GB sponsored and financed the project with each broadcast prepared by a professional broadcaster with the assistance of specialists according to the topic.

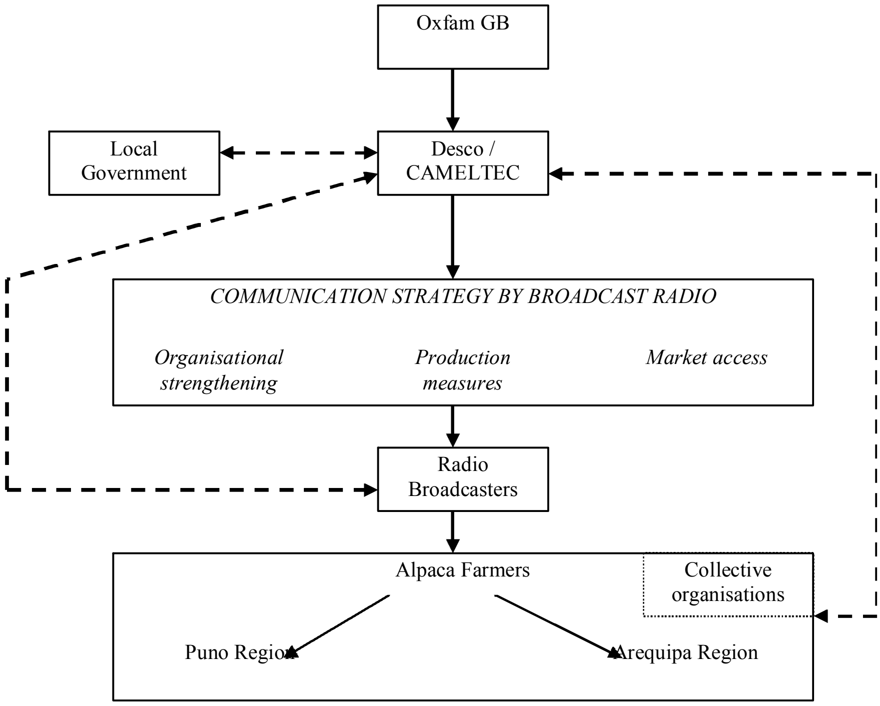

Figure 4: CAMELTEC Project Stakeholders

Impact: Cost and Benefits

The total direct cost of the initiative was US$900 per month, comprising the production and broadcast costs for each of the radio programmes. As noted above, one main climate-related activity was the attempt to reduce the level of death and also diseases within livestock – typically diarrhoea, pneumonia, fever and enterotoxaemia – that rose during the cold snaps. CAMELTEC produced radio programmes on each of these diseases with basis guidance on diagnosis and action to mitigate the effects.

To take one example, the normal annual mortality rates among alpaca herds is 18% in adults and 25% in crias (alpaca calves). If there are extreme cold spells, this rises – for instance to 35% in crias. Since the start of the radio broadcasts, the overall mortality rate has been reduced to 12%; saving an equivalent of US$500 worth of livestock on average per farmer. Of course, the radio broadcasts are only one relatively small part of this – alongside other work by Desco to help farmers improve protective dwellings for their animals, sanitation, handling procedures, etc – and it is not possible to attribute any specific impact to the broadcasts.

Radio is also seen as valuable in addressing gender barriers. For cultural and family reasons, women are often denied access to community farming meetings and have not been able to participate in sharing skills and ideas. Radio broadcasts break at least one part of this by giving farming women opportunities for learning which were unavailable before.

Evaluation: Failure or Success

The radio broadcasts can be seen to have contributed to a number of positive outcomes. As noted, programmes related to disease prevention and control, including protection of babies, and improved calving techniques have contributed to a significant decline in herd mortality rates. Those focusing on construction of shelters, water and fodder conservation, and emergency feed and treatment have done the same specifically for *friaje*. Programmes have encouraged a more systematic approach to breeding, the utilisation of farming co-operatives for marketing of alpaca wool, and a more commercial approach to farming; all of which have helped to either maintain or raise income levels.

The reaction to the radio broadcasts has been overwhelmingly positive among the target audience as evidenced in a feedback survey undertaken by Desco in 2010 showing more than 80 per cent of respondents said they regularly tuned in to the show.

The following testimonies illustrate the feeling from the target audience towards the broadcasts:

> ''The radio show seems very nice. I listen to it every Saturday and I greatly appreciate the work of Desco. I think it has worked very well for us, as we live in the countryside dealing with the cold, the hail and the snow, grazing our herds. Our alpaca wool price has considerably decreased, and it is not enough to feed our children so we are asking for more help.'' (Marcelina Campos Quispe. Alpaca farmer from Vila Vila District, Puno region)
>
> "The show is very funny and it teaches us to prevent livestock illnesses, depending on the season. It has helped us a lot with our lives and we are very grateful. We would also like to have more programmes like this about the latest genetic developments and more about sanitary prevention.'' (Roberto Huaynacho Condori. Alpaca farmer from Vila Vila District, Puno region)

Given the project has only recently finished, it is not possible as yet to ascertain how sustainable any improvements will be. However, the project did show that – despite low technical capacity and limited financial resources – it is possible for radio broadcasts to reach and affect a large audience; suggesting it is a model that others can consider for agricultural adaptation projects.

Enablers/Critical Success Factors

Deep local knowledge and experience were vital to the CAMELTEC project, building as it did on Desco's many years of working with local farmers. Within Desco itself, a key was the use of NGO workers who were drawn from the local area, who spoke Quechua, and who had long experience of the specific rural development issues faced by mountain alpaca farmers.

The same was true of the two local radio stations – Radio Onda Azul in Puno and Radio San Antonio in Arequipa – both of which had worked for a long time in their respective regions. They each had the largest audience share in those regions, based on understanding those audiences, broadcasting significantly in the local language rather than only in Spanish, and offering services such as transmission of messages to family members in remote locations.

The project therefore also brought together a **collaboration of specific expertise**; with Desco providing the development and agricultural components fused with the broadcasters providing the technical components. Finally, **appropriate radio programme design** made an important difference to ensuring a sizeable audience for the shows, but also to ensuring that messages were heard, understood and created the basis for action. When funding to Desco ran out in 2010, some local radio stations attempted – in response to requests from farming families – to provide similar programming. However, lacking the NGO's expertise and lacking the funds to design high-quality programmes, the results have been disappointing.

Constraints/Challenges

The **limitations of radio as a medium** must be recognised. It provides only one-way information at specific times rather than the 24/7 interactivity of other information and communication technologies. Its role is to raise awareness and perhaps to change attitudes, but it cannot deliver skills and is relatively poor at delivering knowledge. Therefore its limited role within any agricultural development and adaptation project must be recognised.

The **general asset constraints** of the target population constrained their ability to turn broadcast messages into actions. Their poverty, malnutrition and limited education all worked against this. And they were also hampered by simple asset problems like the limited availability and high cost of radio batteries.

Finally, **the skew of climate change policy towards mitigation rather than adaptation** is unhelpful. Peru does have policies on climate change but – perhaps following the agenda and lead set by the global North – these have had much more to say about mitigation than about measures to adapt to climate change (Cancino et al 2011). This despite the fairly self-evident fact that a developing country like Peru faces immediate and increasingly widespread problems due to climate change, and makes little contribution to the world's overall carbon outputs.

Recommendations/Lessons Learned

Income is central to adaptive capacity and therefore it is appropriate for projects dealing with ICTs, agriculture and climate change to themselves have a central focus on income generation. This was the case with the CAMELTEC project. The broadcasts and other work on protection from cold snaps were only one small part of a much bigger picture that aimed to improve alpaca herd quality, farming practices, and market access – all this with the main goal of increasing the farmers' income since money is far and away the single most important asset that helps households adapt to climate change.

Radio should be part of a much broader intervention package. The emphasis in this case study has been on the role of radio, and its relation to climate variability. However, looked at overall, the CAMELTEC project was only in small measure about radio. The ICT was therefore used to support – by building awareness, reinforcing messages, and shifting attitudes – the main thrust of the project, which lay around training, market survey visits, formation or strengthening of collective enterprises, negotiation of purchase agreements, participatory budgeting workshops, and a breeding programme. Projects involving ICTs will only be effective if set within this type of broad approach since delivery of information – on its own – achieves little; it only becomes effective in synergy with other interventions that enable information delivery to be converted into action.

Address foundations and not just symptoms. The project could have focused on diseases and animal husbandry. But the root causes of problems in mountain areas typically fall back to issues of income (noted above) and the weak institutional and organisational foundations for the poor. Therefore, as just described, the CAMELTEC project invested much of its work in institutional development activities: training representatives from farming communities; creating collective enterprises such as community wool collection centres; and strengthening the farmer co-operatives so that they could, for example, negotiate better market prices and also engage with local government for participatory budgeting exercises. In all this, ICTs can have some role, but it is relatively limited.

Strengthen radio programming related to climate change adaptation. This would start with a clear understanding of information and communication needs (something many NGOs working with local communities may already have); shape radio programme design to those needs including use of a broad range of local languages; and enable interactive components for example through phone-in segments that make use of the relative accessibility of mobile phones within rural populations.

Data Sources & Further Information

Information for this case study was drawn from the CAMELTEC project including recordings of the broadcast programmes, internal reports, and interviews with representatives of Desco and from the radio stations.

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C4. ICT-Enabled Knowledge Brokering for Farmers in Coastal Areas of Bangladesh

Authors: Patrice Braun and Md. Faisal Islam

Initiative Overview

Bangladesh is at the forefront of climate change, which translates into frequent flooding and soil salinity. For a country like Bangladesh, food security is a key concern with 69% of its population directly engaged in agriculture. Given the considerable contribution of agriculture to the livelihoods of the majority of its people, any significant change in climate has far-reaching impacts on the overall socio-economic system of the country.

With their livelihoods under constant threat, climate adaptation strategies are needed to help farmers cope with natural disasters and fluctuating livelihood conditions. In addition, rural farming communities are often marginalised in terms of timely access to agricultural and market information. An information and communication technology (ICT) enabled knowledge brokerage system known as the *Agricultural Knowledge Management System* (AKMS) was set up in 2006 in the coastal district of Khulna. AKMS brings together organisations, strategies and sources of knowledge required to improve agricultural processes and food security within a framework of climate change. The initiative supports farmers' critical decision-making processes throughout the year, ranging from assistance with crop calendar planning, climate-resilient crop selection, seed purchase, tillage methods, pest control, harvesting, market access and the securing of fair crop prices.

Application Description

The underpinning framework for the Agricultural Knowledge Management System is a multi-stakeholder knowledge flow structure that functions as both a knowledge brokerage and a supply chain management tool (see Figure 1); hence supporting flows of both information and agricultural resources with the aim of improving food security. Consisting of organisations, sources of knowledge, multi-directional communication, and behavioural approaches, AKMS incorporates climate change adaptation issues, and the system continues to be tweaked in response to rising sea levels, increased flooding and saline intrusion of coastal land.

Since lack of connectivity and literacy is still widespread in rural farming communities, information is provided to farmers via knowledge brokers: these are educated youths from participating rural farming communities who work for community-based organisations and are embedded in the community through family ties and are hence highly accepted within their communities. Knowledge brokers map the agricultural, economic and social information and communication needs of client communities (see Figure 2), locate the information if and when needed, provide the information in accessible terminology and the local language at prices that are realistic given farming communities' limited resources.

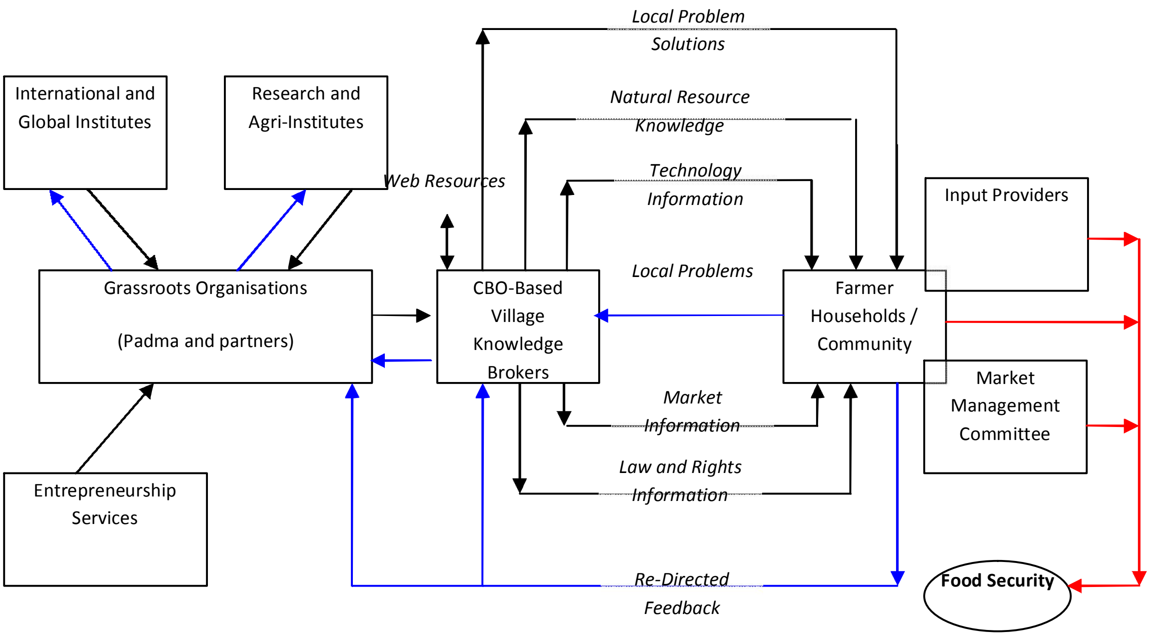

Figure 1: Agricultural Actors and Information/Resource Flows of the AKMS

Note: black arrows represent 'downward' flows of information and knowledge; blue arrows represent 'upward' flows: both of problems and questions that require solutions, but also of feedback on the appropriateness of the downward information flows; red arrows indicate broker-facilitated flows of information and resources within the agricultural supply chain.

Figure 2: Mapping Farmer Information Needs

Equipped with laptops, the knowledge brokers browse online information in Bengali. Due to their understanding of local circumstances, they are then able to convert this information into locally-relevant knowledge and share this knowledge with the farmers; initially face-to-face and on-site and then (once their brokerage relationship is established) via mobile phone. Topics covered would include which crops are best suited to changing climate conditions; developing and adopting climate-resilient seed and crop varieties; climate-friendly methods of production, irrigation and land preservation; and up-to-date market information. Topics without a ready source of online information

– such as product diversification, credit application opportunities, supply chain and labour issues – can also be discussed with the knowledge brokers, who have been trained to source the appropriate knowledge or knowledge provider as required.

If the knowledge brokers are themselves unable to identify relevant information online, then – via the nodal partner, the Padma Research and Development Organisation, which maintains the system and is located in Khulna town – they are able to contact other national and even international agricultural and climate change organisations to seek advice for the farmers; that contact typically being undertaken by email or mobile phone. But AKMS should not be seen as just a one-way flow of information. Based on principles of interactivity and feedback loops for continuous information improvement, the system not only feeds knowledge down from international, national, regional and local sources, it also (shown as blue arrows in Figure 1) feeds information back up the chain.

Formal Drivers

Climate change is expected to have a substantial impact on food production and jeopardise food security in many regions. Bangladesh in particular is recognised as one of the most susceptible to the negative impacts of climate change. Rising sea levels threaten inundation and saline intrusion in the coastal regions of the country. These risks are further accentuated by greater cyclone intensity.

Access to information on climate change adaptation and sustainable agricultural production is vital for marginalised farming communities as better information systems can greatly assist decision-making at all levels. Research suggests strategies involving sustainable agricultural practices that integrate climate change have a number of impacts: they reduce vulnerability and improve food security, human well-being, environmental management and community resilience (Hania & Quirehi 2010; Parry et al 2007).

Figure 3: Map Indicating AKMS-Active Areas

The Jhenidah, Dacopa and Botiaghata sub-districts in the southwest coastal region of Bangladesh (identified by red dots on Figure 3 map), where AKMS has been rolled out, regularly experience natural disasters which cause excess flooding, crop damage and soil salinity issues, resulting in steady soil degradation. This, in turn, creates substantial obstacles to maintaining regular and healthy cropping cycles and directly impacts food security. Traditional technologies used in agriculture are no longer in synch with actual food demand. Moreover, the introduction of hybrid seeds and high chemical inputs for high yielding crops, further contribute to a decrease in land fertility and increased marginalisation of rural farming communities.

Bangladeshi farmers that live in flood-prone areas such as the Khulna sub-districts of Jhenidah, Dacopa and Botiaghata frequently lack basic infrastructure. Over 60% of rural farmers are illiterate and many communities do not have access to information and technology to solve pressing agri-production issues related to soil degradation and climate change. At the same time, rural farmers have valuable tacit knowledge based on longstanding oral traditions that needs to be acknowledged and built upon, so it may purposively be combined with external knowledge on climate change adaptation to create more sustainable farming practices.

Objectives/Purpose for ICT Usage

The ICT initiative started in 2006 in the Jhenidah sub-district of Khulna to bridge the gap between marginalised farming communities and agricultural information (including climate-relevant information). Originally, five pilot villages were selected, targeting approximately 1,500 farming households. The objective of ICT usage, as embodied in the AKMS, is to bring together and create linkages between a wide range of knowledge sources generated by farmers, agri-business experts, climate change adaptation researchers, and stakeholders along the value chain.

From this starting point, a knowledge 'ecosystem' has been designed to provide farmers with the agricultural knowledge they require to improve the management of their land, biodiversity and livestock, and also to cope with climate change. Set up as a knowledge brokerage system to provide marginalised rural communities access to information and sustainable farming practices, the system is managed like any other key business input. It addresses questions such as 'who needs information', 'who can supply the information', 'what format and delivery mechanisms allow the knowledge provider and consumer to communicate and share information', and 'what institutional and market structures provide the appropriate incentives for information sharing to take place'.

Specifically, the purpose of the ICT-enabled AKMS system is to:

- Facilitate multi-directional ICT-enabled information and knowledge flows – the built-in feedback loops allow for continuous information improvement;
- Adopt a common language – information is translated into the local language and brokered in a non-scientific manner;
- Facilitate information and knowledge exchange – the interactive process relies on strong linkages with various agricultural actors that enables grassroots level access to national and global expertise on agriculture and climate change adaptation. Vice versa, these research experts gain practical implementation data and insight into grassroots needs;
- Create a regional knowledge base – on climate resistant seeds, crops, best practices on climate change, irrigation, land preservation, etc.;
- Build a learning community – learning is based on the continuous information updates and knowledge flows between stakeholders;
- Facilitate value chain opportunities – securing timely and sufficient input supplies such as credit, fertiliser, seeds, and fuel; securing crop prices with market committees on behalf of farming communities, and bringing diversification opportunities to the attention of stakeholders;
- Build mutual trust and respect – ensuring both traditional and contemporary knowledge and practices are respected and integrated.

Stakeholders

The AKMS system project was developed by senior management of the Padma Research and Development Organisation: a regional non-profit youth organisation working with marginalised farming communities. Development costs have been supported by various international grants and fellowships, including the Global Social Benefit Incubator Initiative at Santa Clara University in the US and the Youth Social Enterprise Initiative for emerging young social entrepreneurs in developing countries.

Acting as the intermediary, Padma sources and coordinates agricultural and climate change adaptation information from input providers, market management committees, various ministries, local authorities, national and international research institutions and repurposes the same into online and offline information in easy to understand Bengali. Padma also trains the knowledge brokers in ICT and system navigational skills, knowledge sourcing, and community engagement (see Figure 4). The three-pronged training process takes two months and is conducted at the Information Service Centre (ISC) based at Padma's offices in Khulna. Youths from rural communities start by volunteering at the ISC for two weeks, followed by one month intensive training based on the Microsoft 'Unlimited Potential' curriculum. The last two weeks focus on the use and management of information within the AKMS.

Figure 4: Knowledge Broker Training

The knowledge brokers generally avoid issuing prescriptive recommendations; rather, they play an advisory and facilitating role, providing information, communication, and knowledge that allows farmers and farming cooperatives to make better management decisions that will improve their long-term livelihoods.

Impact: Cost and Benefits

While the approximately US$25,000 in AKMS development costs were borne by international grants and fellowships, the current and future sustainability of the system predominantly depend on small subscription fees from participating farming communities and market brokerage fees where applicable. For example, when knowledge brokers facilitate logistics between farming communities and market opportunities, such as securing fair crop prices with market management committees, a brokerage fee is charged. Fees are based on 20% of value addition. For example, prior to being part of AKMS, a farmer might have sold a particular crop for US$10. By obtaining appropriate knowledge via AKMS, that same crop now fetches US$15. Given the US$5 value addition, the AKMS fee for this crop would be US$1.

By applying a participatory and inclusive approach to knowledge brokering, rural Bangladeshi farming communities are linked to international best practice, to one another and to stakeholders along the value chain. Apart from being integral to fostering diversification opportunities and new multi-sectoral partnerships in the region, the system also fosters greater awareness among marginalised farming communities of the need to adapt to climate change and local appropriation of climate adaptation processes.

Marginalised farming communities benefit directly in terms of becoming informed farmers with the system providing opportunities for learning, adoption of new technologies, knowledge exchange, access to timely planting and climate friendly cropping information, which in turn creates crop and food security, market and marketing knowledge, informed negotiation and fair market prices, as well as opportunities for diversification and additional income generation The AKMS has made a particular difference to communities in the south west coastal area which has a mangrove ecology with the soil fertility and siltation processes dependent on upstream and downstream flows and the health of local rivers. Faced with a damaged natural water management system, one such rural farming community was tapping saline water from their fields in an attempt to augment its income by setting up shrimp farming, resulting in the soil losing both its fertility and opportunity to regenerate necessary micro organisms. With guidance from the AKMS, the community became aware of the situation, stopped tapping the soil water in the cropping fields and learnt sustainable cropping practices, including how to access natural water flows. This has resulted in the soil recovering its fertility and an improvement in agricultural livelihoods within the community.

Another case involves Gongram Pur Sabuj Mohila Somity, a 21-household women's farming cooperative located in the Botiaghata sub-district of Khulna. The salinity in the soil in this district is so severe that the cooperative's cropping season has been reduced to about four months per year, which does not provide food security for farming households year around. Until the AKMS intervention, the community employed ad hoc and inorganic farming practices and were unaware that they were further contributing to an imbalance in soil nutrients. Supported by climate adaptation information from the AKMS and from Locos, a German-funded local non-governmental social development organisation, the women have been motivated to adopt organic farming practices, use organic fertilisers and pesticides, and develop saline tolerant crops, which is extending the cooperative's cropping season. With the aid of Locos and the AKMS system, some 49 crop varieties of local indigenous seeds of paddy (rice) have been developed in the region, which are being distributed by Locos to participating farming households.

Evaluation: Failure or Success

The AKMS can be considered to be largely successful. The knowledge management system has been populated with a wide variety of agricultural information, including information relevant to climate impacts on the mangrove ecology in the region e.g. on eco-balanced organic and hydroponic farming, saline tolerant cropping varieties, fish cultivation for flooded open water bodies, vulnerability trend analysis tools and climate change adaptation strategies.

Linkages have been made with national and international information and knowledge institutions, such as Khulna University, Santa Clara University, the Foundation For Youth Social Entrepreneurship, South Asian Network for Development of Environmental Economic, and the UK's Department For International Development, among others.

A total of 176 youths have been trained to date, 73 of whom are presently working as knowledge brokers. The AKMS has assisted 3,780 farmers in five villages to increase their income and food security. Farming communities such as Gongram Pur Sabuj Mohila Somity are getting fair returns from their crops, are serving as a best practice example for other communities and are contributing to setting the standard for organic and sustainable farming practices.

Today 94% of AKMS revenue is generated through its products and services to farmers with the remaining 6% being derived from donations and grants. While no external expressions of interest have been received to expand the system, between 2008-2009 the project achieved a 20% profit margin, which is expected to rise to 35% by the end of 2011.

Enablers/Critical Success Factors

One of the critical success factors of this initiative is the **inclusive approach to collecting and disseminating climate adaptation information**, including the building on indigenous knowledge as the point of departure. The interactive multi-stakeholder system fills gaps in climate adaptation content and repurposes the content in a language and terminology that is acceptable to its target users. This approach provides even the most marginalised communities access to climate change adaptation knowledge and broader agricultural knowledge, builds capacity and contributes towards more sustainable livelihoods.

The other critical success factor is the **training of youths from participating farming communities**. Because they originate from – and have family within – the farming communities, the youths are accepted more easily by the farmers. They also have *a priori* knowledge of the socio-economic community make-up and micro climate conditions. This speeds up the knowledge mapping process and the creation of a trusted relationship between the community and the knowledge broker. Communities are more open to sharing their insights, on which youth are able to map their climate change adaptation needs.

Constraints/Challenges

Among the main challenges for this initiative is the **lack of infrastructure**, both physical and ICT infrastructure to ensure timely delivery of information to communities that are isolated, flooded and otherwise hard to reach. This is compounded by the **high level of farmer illiteracy and lack of technology skills**. For many regions, particularly in rural areas, direct use of ICT by farmers – with the exception of mobile telephony – may take decades. To that end, the system is increasingly utilising mobile technology to provide participating communities with the information they need. Once a face-to-face brokering relationship has been established, follow up is often via mobile phone.

A related challenge is the **management of wider stakeholder relationships**. There are challenges like discussing acceptable agreements and timely coordination between the farmers, market management committee, and input providers. Effective performance of knowledge brokers is essential to overcome these challenges as they are catalysts for the participatory approach.

Another challenge is **obtaining relevant climate adaptation information** needed for sustainable farming practices. For a relatively obscure regional knowledge management system it is not easy to link to reputable agricultural research institutions. Moreover, such research as they provide is often highly academic, too complex to guide the knowledge brokers, and difficult to translate into easy to use adoption practices by the farming communities. The problem is fundamentally one of a lack of coordination between climate adaptation theory on the one hand and the climate adaptation practice on the other. Farmers need less academic feedback and more practical tools from agricultural research institutions. Moreover, micro climates and farming communities are not homogeneous in nature and therefore one size solutions do not fit all. Climate change solutions and strategies that can be embraced by farming communities will vary according to their geographical location, infrastructure, available resources, socio-economic make-up, culture and local context. The managers of the AKMS are instrumental intermediaries in terms of conveying grassroots needs to climate adaptation theorists and repurposing and contextualising climate adaptation information for the local market.

To date the AKMS has been funded by grants, fellowships and brokerage fees. The **maintenance and future sustainability** of the system itself is, however, not secure and creates a challenge in terms of the continued need to keep content and knowledge brokers up to date. There are also some challenges pertaining to the coordination of timely information for farming communities, which is subject to obtaining timely content from input providers, market management committees, and other stakeholders along the value chain.

Recommendations/Lessons Learned

- **Integrate climate change into broader agricultural information systems**. Farmers in the coastal regions of Bangladesh (as in many other coastal regions of the world) are already having to live with the consequences of climate change. However, they do not require a specific climate change information system because climate change is only one of the issues they face. Instead, AKMS has been effective because it is a general agricultural information service. It is therefore able to address the whole range of problems that farmers face, rather than just restricting itself to climate change; a restriction that would likely have led to great frustrations for the farmers.

- **Provide information <u>and</u> other resources**. Were AKMS only a provider of information and knowledge, it would be useful but very limited. But it has been designed to also support the provision of agricultural inputs, and the sales of agricultural outputs. It therefore offers not just advice – for example about adaptation to climate change – but also the mechanisms by which that advice can then be turned into practice.

- **Community-based intermediaries are vital to climate change adaptation**. You cannot connect the average developing country farmer directly into global, expert information on agricultural adaptation to climate change; for the reasons described above under 'Challenges'. Thus for all rural communities facing the threat of climate change, the knowledge broker model or some variant thereof will be essential – especially the fact of training someone who is already a community member. The knowledge broker can be seen to perform so many vital intermediating roles: translating external information into locally-relevant messages; integrating global and local knowledge; bridging the power gap between farmers and supply chain institutions; bridging the digital gap between farmers and the global ICT infrastructure; and so on.

- **Climate change awareness should precede information, resources and action**. Farmers are well aware that they have problems, but the causes of those problems and their relation to climate and climate change are often not well-known. Sensitising rural communities to these issues and getting the farmers to understand their climate adaptation needs, is a first step, then to be followed by access to contextually relevant climate adaptation information and resources, leading to action.

- **Climate change adaptation information must be locally-relevant and action-oriented**. At present, rural adaptation projects face a two-step barrier. First, there is very little information about adaptation to climate change. Second, what information there is often is of the wrong type for rural communities: too generic, too academic, and too reflective or suggestive. Thus many projects will have to start by enabling the creation of appropriate information before they can begin to help farming communities take action.

- Overall, **design guidelines for an effective climate adaptation knowledge system** are that it should:
  - Build on traditional knowledge;
  - Consider local context;
  - Strengthen value chain communication;
  - Contain simple to understand and easy to manage/update climate adaptation content;
  - Use embedded knowledge brokers;
  - Adopt a participatory approach; and
  - Have low knowledge transaction costs.

Data Sources & Further Information

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C5. e-Adaptation within Agricultural Livelihoods in Colombia's High Mountain Regions

Author: Angelica Valeria Ospina

Initiative Overview

The increasing manifestations of climate change – extreme weather events and greater climatic variability – are posing serious challenges to agricultural livelihoods in developing contexts. In countries such as Colombia, the increased frequency and intensity of climatic phenomena such as El Niño and La Niña have caused devastating socio-economic and human damage (RI, 2011). This has demonstrated the need for innovative strategies to strengthen the capacity of vulnerable communities to better prepare, respond and adapt to these effects.

Colombia's agricultural communities have been severely affected by the impacts of climatic uncertainty and volatility. These communities operate within contexts characterised by multiple resource constraints (e.g. lack of economic resources, low levels of education and skills, precarious infrastructure), social and political marginalisation; challenges that are intensified by the geographic remoteness and complex topography of mountainous regions.

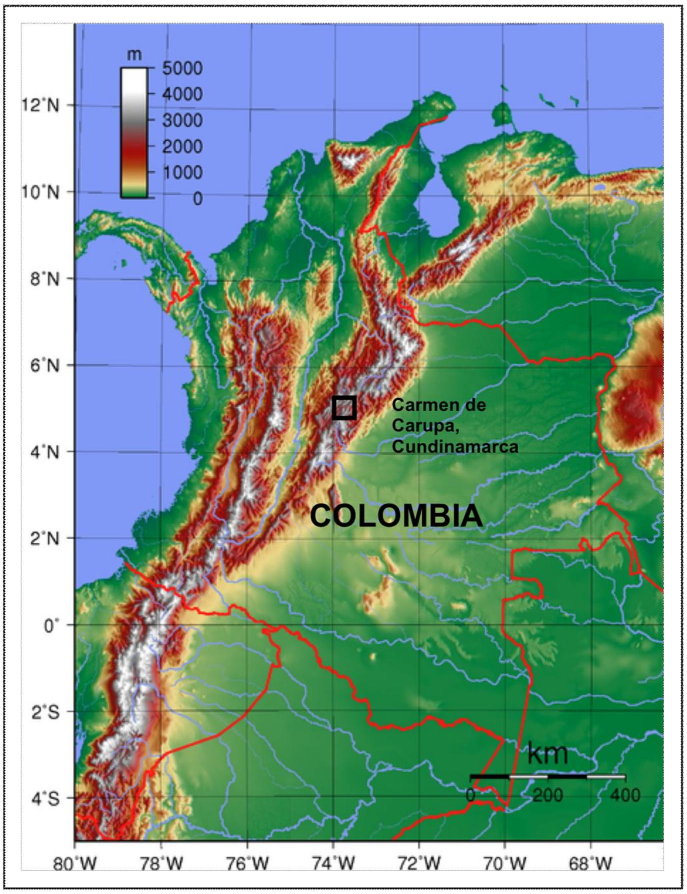

Figure 1: Topographic Map of Colombia. Source: Sadalmelik (2007)

Recognising the need to foster innovative approaches to climate change adaptation within these contexts, the Colombian Corporation of Agricultural Research (in Spanish: Corporación Colombiana de Investigación Agropecuaria, CORPOICA) implemented a pilot project aimed at exploring the role and potential of information and communication technologies (ICTs) to strengthen the adaptation capacity of agricultural communities to climatic variability.

The six-month pilot project was conducted in Carmen de Carupa, a municipality located in the Andes mountain range and thus, characterised by high altitude terrain from 2,600 to 3,400 meters above sea level (Figure 1). Local livelihoods are highly dependent on potato production, and to a second extent on cattle farming for milk production, activities that are highly vulnerable to the impacts of climate change and variability. Potato production in the area has been particularly affected by changing seasonality, more frequent and severe frost episodes, as well as by prolonged drought periods associated with El Niño weather patterns, which affect agricultural productivity.

The selection of the project area was based on criteria that included: the local production system (agriculture-based), the availability of local experience working with participatory research projects, a high degree of community organisation (e.g. active producers' associations), a low degree of impact by the 2011 La Niña weather event but heightened awareness of climatic effects and future uncertainty, previous CORPOICA experience in the region, as well as the accessibility of the location, among others. The project tested and analysed the use of radio and Internet based applications in Carmen de Carupa, and introduced the role of local Youth Promoters of ICT tools for climate change adaptation.

Application Description

In terms of ICT applications, the approach of this pilot initiative was two-fold, as it tested the use of both traditional and emergent ICTs through a combination of community radio and Internet-based applications.

- Four community meetings and a survey conducted among 150 respondents at the start of the pilot's implementation suggested that **radio** was one of the most widespread ICT tools in the region, due to its low cost, high penetration and easy access (particularly by older generations, who constitute the majority of local producers), as well as the flexibility of its use (e.g. potato producers and collectors are used to listen to the radio while they are working in the fields). Further to this, the use of the radio is deeply embedded in the local culture due to the presence of a local station called 'Cristal FM Stereo' that covers the entire area of the municipality, as well as adjacent municipalities (e.g. Ubaté, Cucunubá, Tausa).

  Local municipal authorities provided support in order to secure a space for the transmission of a series of bi-weekly programmes called "On Air With The Fields" (in Spanish: "Al Aire con el Campo") in the local radio station. Each programme had an average duration of 20 minutes. The themes covered during each broadcast were demand-driven, that is, selected based on the issues raised by community members during the four meetings that were held, through an initial in-depth interview survey, and two follow-up surveys that were focused on getting feedback from the radio programme. The contents of each broadcast were prepared collaboratively by local stakeholders and the project team, in non-technical language, and integrating humour and practical examples that producers could relate to.

  Issues covered by the programmes include the concept and impacts of climate change and variability at the local level, agricultural best practices, cattle-farming best practices, as well as the concept and potential of ICTs within the context of the municipality. These topics were addressed by different 'invitees', including agricultural researchers, representatives of local producers' associations, producers and Youth Promoters (Figure 2).

  Project stakeholders (e.g. Youth Promoters, representatives of producers' associations, and

CORPOICA researchers) worked together in the production of a musical 'jingle' for 'On Air with the Fields' (composing a melody that was memorable for the listeners), as well as in dissemination activities. In order to complement the issues addressed through the radio programme and to broaden the reach of the messages, the broadcasts were documented through a set of hard-copy booklets, written in user-friendly formats and images, and distributed in the area.

Figure 2: Youth Promoter Broadcasting the Programme 'On Air With The Fields'

- The use of the **Internet** was also identified as a key component of the pilot's approach, based on the increasing availability of computers in local schools, as well as the high interest and motivation of youth in using these technologies. The integration of Internet-based applications was done mainly through the "Youth Promoters", a team of local youth that was trained, among other skills, in the management of Web-based information, the use of e-mail, the use of the Web as a repository of information, as well as basic aspects of Web design and video production. As a result of the training provided by CORPOICA, the Youth Promoters created and managed a project e-mail address used to coordinate activities and exchange information with team members, and designed a project Web page (https://sites.google.com/site/procarupa/) describing the main objectives and activities of the project, the context of implementation, and their role as 'promoters' (group pictured in Figure 3). The Web site allows visitors to download "On Air With The Fields" programmes, and provides a link to a YouTube channel (http://www.youtube.com/user/CarmenDeCalupa) created by the Youth Promoters to share local experiences and raise awareness on the impacts of climate variability in Carmen de Carupa.

Figure 3: Group of 'Youth Promoters' Accompanied by the Leader of a Local Producers' Association

Formal Drivers

Sources in the field suggest that, especially during the last decade, hydro-meteorological hazards of small and medium magnitude have increased in countries such as Colombia (Ruiz Murcia, 2010; RI, 2011). Given its geographical location, prevailing development challenges and high heterogeneity in terms of topography, climate, ecosystems and biodiversity, this country is at the forefront of the effects of interannual climatic variability. These effects include changes in the length, frequency and severity of dry and rainy seasons, as well as the occurrence of extreme events (Baethgen, 1997, IDEAM, 2010). While in the past local producers could identify with a high degree of certainty the months of the year when they could expect higher levels of precipitation or drought, testimonials gathered through community meetings and surveys indicate that the occurrence, duration and strength of those periods are increasingly uncertain.

At the same time, longer term climatic manifestations such as the loss of snow-covered areas and moorlands, temperature increase and changes in patterns and volumes of precipitation, among others, are posing serious challenges to the country's adaptation capacity (WB, 2009; IDEAM, 2010). With approximately 39% of its land dedicated to agriculture (WB, 2009), Colombia's rural livelihoods are particularly vulnerable to these fluctuations, as periods of unusually intense or unpredictable floods and drought have devastating impacts on crop productivity and food security.

In mountain communities such as Carmen de Carupa, the occurrence of more frequent and intense El Niño periods has negatively affected the production of potatoes (e.g. due to the erosion of the soil, the loss of nutrients, the spread of plant diseases, among others) as well as cattle farming activities (e.g. due to decreased pasture and increased disease among the animals, among others), ultimately weakening local livelihoods. Within most rural areas, particularly those located in high mountain regions, the availability and access to relevant information and knowledge to cope with these impacts is very limited, and the provision of connectivity is still precarious.

While an increasing number of climate change adaptation initiatives is being implemented in the country, the use of ICTs has been, for the most part, secondary to other tools and approaches, not acknowledged or integrated explicitly into the projects' strategies. Thus, this pilot project emerged as a response to the need of addressing the increasing challenges posed by climatic variability within vulnerable agricultural contexts in Colombia from an innovative perspective, one that explores the role of ICTs as part of an integral approach to address challenges related to the creation, management and dissemination of information that is relevant to the adaptation of local livelihoods.

Objectives/Purpose for ICT Usage

The aim of the pilot project was to contribute to the design and implementation of innovative strategies to strengthen the adaptive capacity of Colombia's agricultural sector to the impacts of climatic variability, through the use of ICTs. The specific objectives were:

1. To identify the information needs of the selected location, in order to focus the project's implementation on content and applications that help strengthen local perceptions on the challenges posed by climatic variability.

2. To test and analyse the use of selected ICT applications, including their role in the creation, dissemination and appropriation of relevant information.

3. To identify the challenges faced within local production systems, as well as the potential role and contribution of ICTs.

The role of ICTs was closely linked to addressing the prevailing information needs and priorities of local agricultural livelihoods, more specifically in regards to the effects of climate variability on production systems, as well as perceptions on the need to adjust and adapt to those effects.

Stakeholders

The stakeholders that participated in the project's implementation can be categorised around three main axes:

a. Lead Organisation: CORPOICA, a national research organisation linked to Colombia's Ministry of Agriculture and Rural Development.

b. Local Youth Promoters (Knowledge Infomediaries): The "Youth Promoters of Adaptation to Climatic Variability Using ICTs" (in Spanish: "Promotores Juveniles de Adaptación a la Variabilidad Climática Mediante el Uso de TICs") consisted of a group of local youth (ranging from 18 to 23 years old) that implemented and fostered the project in Carmen de Carupa, interacted with local stakeholders on a continuous basis, collected information (e.g. via surveys, interviews, videos and photographs) and promoted the use of ICT tools to adapt to the impacts of climatic variability at the local level. The selection of these knowledge infomediaries was conducted through an open call for applicants in the municipality, followed by a competitive selection process that involved two stages of practical tests and interviews. In addition to their age, selection criteria included having a high-school diploma, being originally from and residing in Carmen de Carupa, having experience of and being able to demonstrate engagement in community-based activities, and having strong communication and leadership skills, among others.

The candidates selected were engaged in the project through a contractual agreement for the duration of the pilot. They received basic training by CORPOICA experts in the three key areas that intersect the project, namely (a) productive systems, agricultural and cattle farming best practices, (b) climate change and variability, and (c) ICTs (radio and Internet-based applications). The group also received training in basic research skills (e.g. survey design and application, and analysis of findings) and in the preparation and delivery of radio programmes and public presentations.

c. Local Stakeholders: These included local producers' organisations (Asoagroalizal), the local radio station, the Mayor of the Municipality, potato producers (land owners or tenants of productive land) and field workers (i.e. potato collectors, working on a daily basis for producers), cattle farmers, traders of agricultural inputs (e.g. fertilisers, seeds), as well as other actors interested in environmental issues (including representatives from the Local Committee for the Prevention and Attention to Emergencies and Disasters, CLOPAD, and the Municipal Unit of Agricultural Technical Assistance, UMATA, and the local priest, who participated in some of the meetings).

The project stakeholders and the main activities involved in their two-way interactions are reflected in Figure 4.

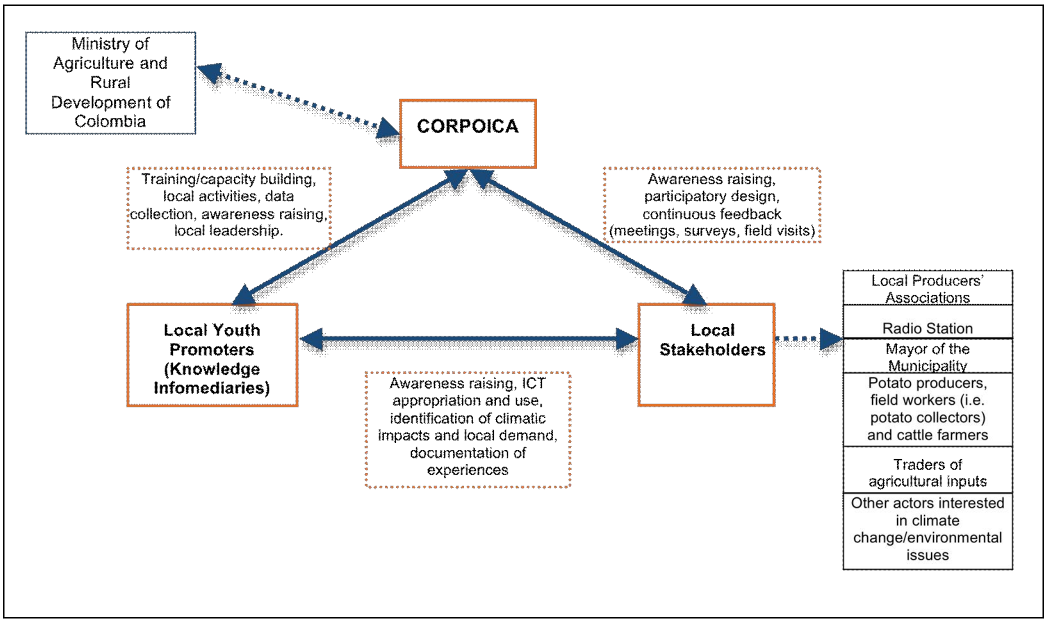

Figure 4: Map of Project Stakeholders. Source: Author

Impact: Cost and Benefits

The primary investment by CORPOICA, the implementing organisation, was approximately US$30,000. This amount does not include the proportional salaries of the senior research staff from CORPOICA who were involved in the project (e.g. project leader and main investigator), but it covers the support staff (e.g. junior researcher), the cost of local meetings with community stakeholders and field visits, the training and monthly stipend of the Youth Promoters, the implementation of two surveys in the municipality, as well as the engagement of an external project advisor. There were no costs associated with the radio programmes, given that there was a partnership with the local radio station and the production was conducted with the support of CORPOICA's communication experts.

The assessment of this initiative is based on that fact that it was designed as a *pilot* experience, with a very limited implementation period (six months), and therefore, a limited scope in terms of expected impacts. While the timeline and exploratory nature of the experience did not allow a conclusive identification of changes in the adaptive capacity of the target community, the pilot was successful in terms of providing useful lessons that can be considered by future projects at the intersection of climate change/variability and ICTs within rural agricultural contexts.

The pilot provided a series of methodological guidelines for the design and implementation of projects in this field, which can be adapted and used in future initiatives (including criteria for the selection of the project's location, methods for the identification of local climate change priorities, information needs and ICT tools, as well as a training module for Youth Promoters at the intersection of agricultural practices, climate variability and ICTs).

The project also opened new and strengthened existing communication channels between key actors from the macro, meso and micro levels that are already working or are interested in climate change/variability related topics in the municipality (e.g. CORPOICA, several producer associations, producers and community members).

The active engagement of producers' associations and local stakeholders through meetings and events, as well as the role played by the local Youth Promoters evidenced the importance of knowledge sharing and networking. But it also evidenced that further efforts need to be made in order to improve inter-scale communication channels (between macro, meso and micro level stakeholders) as well as inter-generational knowledge exchange between the local elders and youth, particularly around climate variability and the improvement/adjustment of agricultural practices.

Data gathered throughout the project (e.g. through two surveys focused on the usefulness of the radio programmes conducted among three hundred respondents, feedback gathered at four community meetings, key stakeholder interviews and two final workshops to disseminate the pilot's results, one in Carmen de Carupa and one in Bogotá) suggests that project activities were successful in raising awareness on the importance of implementing innovative approaches to tackle the challenges posed by climatic variability within agricultural contexts, integrating ICTs and productive priorities.

Figure 5: Group of Potato Workers of Carmen de Carupa

In terms of its specific objectives, the project was helpful in giving visibility and generating discussion around the use of ICT tools within agricultural livelihoods impacted by more frequent and intense climate events. It also helped in identifying information needs related not only to meteorological and climate-related information, but also to best productive practices in order to prepare and adjust local livelihoods facing increasing climatic uncertainty. The project tested and analysed the use of two ICT applications (i.e. combining traditional tools such as the radio, with more 'modern' ones such as the Internet), as well as the creation and dissemination of appropriate content at the local level.

Through a series of participatory meetings and events, and particularly through the role of the Youth Promoters, the project was able to identify the key challenges faced by the local production system (including those intensified by climatic variability), raise awareness and identify needs in regards to good agricultural and cattle farming practices, as well the main areas where ICTs could contribute to adaptation.

Additionally, the implementation of the pilot helped consolidate CORPOICA's strategy for technology transfer, as well as to test communication channels and methodologies to reach new audiences (i.e. field workers and small potato producers, pictured in Figure 5). It also helped strengthen CORPOICA's collaboration with the local municipal authorities (i.e. the Mayor and his team of advisors), fostering future interactions in the design of the municipal development plan in regards to agricultural issues.

At the time of writing, CORPOICA was exploring the possibility of funding a multi-year project integrating ICTs and climate change variability in rural agricultural regions, based on the results and experiences derived from this pilot.

Enablers/Critical Success Factors

- The role of local **Youth Promoters** or knowledge infomediaries was key to ensure the appropriation of project activities at the local level. Being from the municipality, the youth had an 'insider's' understanding of local actors and challenges, were familiar with local customs and the local language, and had the trust of local actors, which facilitated the process of data collection (through surveys and interviews) as well as the provision of support with the use of ICT tools. Their role was supported locally by leaders of key producers' associations who helped foster the role of the promoters and facilitated access to information.

- The adoption of a **productive systems perspective** throughout the project's implementation ensured a close link between the local productive system/agricultural livelihoods of Carmen de Carupa, the impacts of climatic variability at the local level, and the use of ICTs. This approach facilitated the understanding of the project by local stakeholders and the engagement of a wide set of actors, who felt that the project responded to concrete issues and needs related to their livelihoods.

- The production of **relevant content** (e.g. addressing local needs and priorities, using user-friendly language and formats) was a constant priority throughout the project's implementation. Community meetings, workshops and surveys were conducted in order to gather local inputs on key priorities and concerns, which were then used as the basis for the radio programmes and the design of the project's Web page. In terms of content, the pilot's approach was bi-directional, providing and disseminating information but also training and supporting the role of Youth Promoters in the creation of local content and in the dissemination of their experiences through the Web page and the radio programmes.

- The use of a **multi-stakeholder approach** was very valuable in order to ensure local support for the pilot's activities, as well as for integrating different views and priorities in the design of the project activities. This approach was reflected in the partnership with the local radio station, the fact that the themes covered by the radio programmes were based on the producers' demand gathered through surveys, the continuous support of local producers' associations, and the participation of a varied set of community members in each of the meetings and events that took place during the project. The fact that the project's approach was not limited to potato producers (as most agricultural projects implemented in the region) but also engaged associations, youth, field workers, the radio station and other actors interested in environmental issues, constituted a novel approach that generated interest and community engagement.

- The **trust and credibility** of the lead organisation, CORPOICA, and the fact that it already had experience working in the region, were critical factors in the project's implementation, particularly considering the short timeframe available to conduct the activities. CORPOICA is a respected actor in the municipality, with a solid reputation in agricultural research and technology transfer, which contributed to the support and engagement from local actors.

Constraints/Challenges

- From the ***operational*** point of view, one of the main constraints faced by the project was the **limited timeframe** for implementation. Ensuring community awareness and understanding of the project, and gathering local feedback required more time than initially projected, given that the topic of ICTs for development and climate change were very new to the community. As the initial stage of building the project's foundation and partnerships at the local level was extended, less time was left for the testing and assessment of ICT applications.

- From the ***strategic*** point of view, the **management of multi-stakeholder** relations is complex, and can divert valuable time away from implementation activities. A careful balance has to be reached between the establishment of partnerships with key actors, and preventing project activities being politicised or used in favour of individual agendas. Building local partnerships required weekly visits to Carmen de Carupa by CORPOICA staff, which is approximately three hours by car from the organisation's headquarters. The need for continuous travel sometimes became challenging for team members, whose work agendas included other projects and responsibilities.

- From the ***implementation*** point of view, the project faced challenges in terms of the lack of **connectivity** in the area selected for the pilot, as well as in the lack of **local capacity** in the use of certain applications (such as the Internet), which ultimately limited the extent to which some ICTs could be tested during the timeframe of the project. For example, the absence of Internet connectivity in the local school limited the possibility of providing capacity building sessions or practical demonstrations of Internet-based applications for community members. At the same time, low levels of literacy and the basic use of mobile applications (in most cases limited to making and receiving calls) restricted the viability of using text messages to disseminate project information. While the use of the **radio** allowed a broad dissemination of project activities, real-time two-way interactions with the audience did not take place during the programmes' broadcasting. This was related to the fact that most programmes had to be pre-recorded due to time or travel constraints of the weekly invitees. Additionally, while the Youth Promoters continuously gathered feedback from the community on key issues and priorities to be addressed during the radio programmes, the limited time for implementation did not allow a measurable contribution of these programmes to local adaptive capacity or skills.

Recommendations/Lessons Learned

The key lessons learned and recommendations from the project for future initiatives in the field are:

1. Local productive systems are the starting point for livelihoods' adaptation. The adaptive capacity of the agricultural sector to climatic variability is closely linked to the ability of local producers to adjust their productive activities, in terms of changing the production inputs (e.g. fertilisers, disease control mechanisms, seed varieties) or outputs (e.g. market insertion and product distribution), or even the re-location of their productive activities to more favourable locations. Thus, acknowledging the flow and needs of the local productive systems, as well as the impacts of climate change and variability (among other stressors) in those systems, constitutes the starting point for the design of e-adaptation strategies (Ospina & Heeks, 2010).

2. The active engagement of a trusted institution(s) is critical in the promotion of ICTs' role in the adaptation field. The role of institutions (from national level research institutions like CORPOICA, to local producers' associations) in projects at the intersection of the ICT, climate change and development fields is multi-fold: on the one hand, they enable access to key resources required for adaptive actions (e.g. capacity building of infomediaries, access to new information on agricultural practices, access to traditional knowledge from community elders), and on the other, they strengthen their own institutional capacity to deal with the challenges posed by climate change (e.g. through new skills/expertise on climatic impacts and ICTs, increased flexibility and understanding of local contexts, new partnerships and channels of communication/networking). Thus, the design and assessment of projects in the e-adaptation field should aim at building not just the adaptive capacity of the target population/community, but also the adaptive capacity of the implementing organisation(s).

3. The implementation of e-adaptation projects involves multi-scale interactions (i.e. between actors at the macro, meso and micro levels), **multi-sectoral interactions** (i.e. inter and intra sectoral interactions), as well as **multi-temporal interactions** (i.e. between new and traditional knowledge sources).

Therefore, **e-adaptation practitioners** should aim at integrating the role of ICTs at three levels:

(a) Information and knowledge exchange between actors at the international, the national and the local level.

(b) Information and knowledge exchange between actors from different sectors (e.g. between the Ministry of Agriculture and universities or private sector firms), as well as collaboration and exchange among actors from the same sector (e.g. between the Ministry of the Environment and the Ministry of ICTs).

(c) Covering the impacts of climate change and variability in the short and the long term (e.g. acute impacts such as floods or extreme frost, as well as chronic impacts such as temperature rise); as well as inter-generational dialogue (i.e. between elders and youth) in order to foster more inclusive and sustainable approaches to adaptation, facilitated by knowledge infomediaries, and based on the use of new and traditional knowledge.

These interactions are reflected in Figure 6.

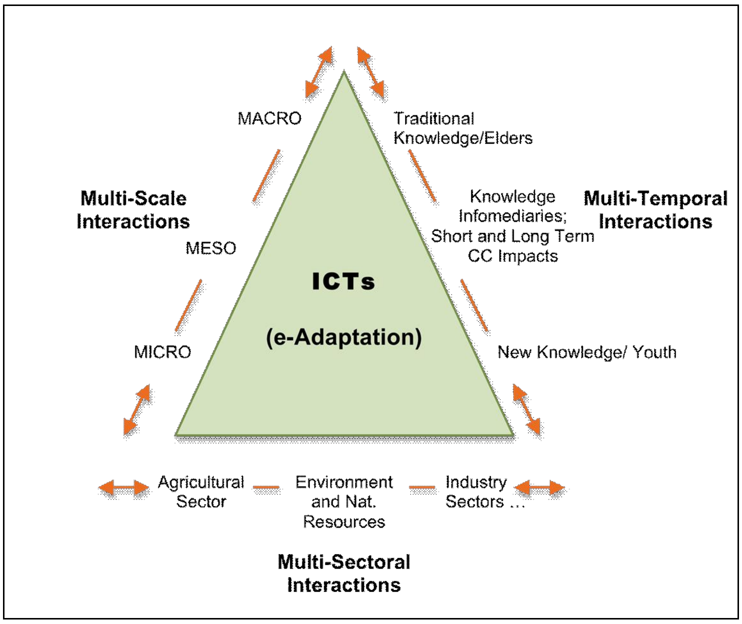

Figure 6: Interactions Involved in ICT-Enabled Adaptation (e-Adaptation). Source: Author

4. A flexible approach for selecting and combining new and traditional ICTs (e.g. radio and Internet-based applications) is key for the success and the sustainability of e-adaptation projects within vulnerable settings. Practical approaches should build upon partnerships with local organisations that have ICTs (e.g. radio stations, schools, telecentres) in order to benefit from the potential of available infrastructure and contribute to the sustainability of activities (post-project implementation). e-Adaptation projects should also consider the integration of interactive, bi-directional applications that allow for real-time exchange among project stakeholders (e.g. mobile-based applications and Web 2.0 tools).

Data Sources & Further Information

The case study is based on the experience of the project titled "The Role of ICTs in the Strengthening of Adaptation Capacity to Climate Variability in Colombia's Agriculture", a pilot initiative implemented by CORPOICA (a public institution, responsible for generating scientific knowledge and technological solutions through research, innovation, technology transfer and capacity building, in benefit of Colombia's agricultural sector. http://www.corpoica.org.co).

The author was engaged in the project in an advisory capacity. The preparation of the case study was based on review of project documents, key informant interviews, observation and community meetings in Carmen de Carupa, the analysis of two surveys conducted among local stakeholders, as well as feedback provided by the CORPOICA project team.

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- Producers' Associations: Martha Pinilla (Asoagropecuaria) and Luis Hernando Moncada (Asoagroalizal).

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Part D: Case Studies of *ICTs and Climate Change Mitigation*

D1. Combining Local Radio and Mobile Phones to Promote Climate Stewardship

Authors: Ryan Jones and Bill Siemering

Initiative Overview

Among the remote, rural communities on the Eastern edge of Zambia, along its border with Malawi, it seems an unlikely place to talk about the impact of human activity on the long-run future of the global climate. However, as the population throughout the region continues to grow, and swelling numbers of urban poor continue to use charcoal as the only means of cooking their food and warming their homes, forested communities like these find themselves in the middle of a global crisis. Every day, black-market charcoal traders clear forests throughout these communities, including in supposedly protected reserves, to satisfy the growing need for cooking fuel in both countries. This widespread activity not only strips carbon-fixing forests out of the ecosystem, but the subsequent burning of the charcoal itself, an inefficient and dirty fuel, is a significant climate and public health problem. Still, the scale of the market, combined with relatively weak enforcement in both countries, makes top-down mitigation of this problem impossible, so organisations throughout the region are now focusing on bottom-up strategies, by both helping the poor find and afford alternatives to charcoal cookstoves and by working with stakeholders near the forests to help mitigate deforestation at its source.

Information, especially comprehensible and efficient dissemination of information throughout often widely dispersed communities, is a critical part of stakeholder engagement. In many of these communities, where poverty is high and infrastructure is largely inadequate, simple technologies like radio and basic mobile phones are incredibly effective channels for distributing and interacting with stakeholder communities. This case study focuses on our pilot project, which aimed to bring effective radio programming and mobile-phone based interaction to these communities, in an effort to increase their knowledge of the local deforestation issue and deepen their stake in reversing the trend.

With support from the Foundation to Promote Open Society, Developing Radio Partners (DRP) launched the one year pilot project in these border communities, working in partnership with three local radio stations in each country. The primary aim of *Zachilengedwe Tsogolo Lathu*, as the participants named it ("Our Environment, Our Future"), was to empower rural Zambians and Malawians to address key climate change issues, especially local deforestation, by improving their access to information on the subject via radio and mobile phone, rural Africa's two most ubiquitous and trusted ICTs. The substance of these projects focused on both climate change mitigation, by emphasising the value of the local forests in both economic and ecological terms, and adaptation, by sharing insights into ways that rural households could preserve their households in the face of a changing and uncertain climate.

Application Description

ICT was a key part of the success of *Zachilengedwe Tsogolo Lathu*. By focusing on the two simple, cheap, and ubiquitous communications media in the project areas – radio and basic mobile phones –

this project was able to implement communications systems and strategies that were effective and sustainable, requiring almost no outside expertise or financial support to maintain.

Radio. Radio was the anchor of our engagement approach and local radio stations the key partners in this project. Because of the relatively low cost of radio infrastructure and receivers, and the wide reach of radio signals, small community stations are an appropriate and often only source of locally relevant information in remote rural communities like those in our project area.

Mobile Phones. Radio is an instant and ubiquitous medium for mass communication, but it is, by its nature, a passive broadcast mechanism. To ensure that we were really reaching the targeted stakeholders, and to deepen their engagement with the lessons and information being shared in radio broadcasts, we tapped another nearly ubiquitous communications tool in the region: the basic, humble mobile phone. In order to facilitate mass interaction, rather than simply one-to-one conversations, we used the free, open-source and innovative software platform FrontlineSMS. By connecting a GSM modem to a radio station's computer, Frontline SMS routes text messages to a computer screen rather than a mobile phone, making it easier for radio staff to see and respond to messages, as well as to gauge the overall sentiment of participating listeners. For example, after a segment on the impact of deforestation on the climate was presented, radio hosts could ask poll questions or solicit feedback, to see what lessons were sticking with their audience.

Formal Drivers

Charcoal- and wood-fired cookstoves are a hydra-headed threat to global wellbeing, especially in terms of our climate (see Figure 1). Since using the stoves means both cutting down carbon-sequestering forests and burning the resultant carbon, they represent a two-pronged threat to climate stability. As the same time, inhalation of the smoke from the stoves, which are usually used indoors, is creating a serious public health hazard. In countries like Zambia and Malawi, where as much as 90 percent of the population use wood to heat food, there is no more immediate threat to the climate and health than the cookstove status quo. A December 2009 article in the *New Yorker* called the stoves a "universal environmental threat" and suggested that cleaning up emissions of the stove "may be the fastest, cheapest way to cool the planet" (Bilger 2009).

Figure 1: Cooking with Wood, Mchinji, Malawi

Recognising the two-way threat – climate change threatens the livelihoods of the poor but those livelihoods themselves pose a challenge to climate stewardship (as well as to public health) – both Zambia and Malawi have national action plans to mitigate and adapt to climate change. Acknowledging the scale and scope of the problem, the plans emphasise community-level interaction, and specifically target locally influential institutions like radio stations as key channels to positively change behaviour and spread information about clean alternatives to charcoal stoves. DRP agrees with the assessment of both the scope of the problem and the right ways to solve it, and this is a key reason why we chose this rural, forested region as the target for our pilot.

Objectives/Purpose for ICT Usage

The goals for this project were three-fold:

- To strengthen the capacity of community radio stations to deliver accurate, informative, and engaging content on topics such as deforestation, conservation farming, clean cookstoves, and climate change to listeners in the project area.
- To use FrontlineSMS to engage listeners and create a participatory media environment, a proven approach that deepens the stake of listeners in the stories they are hearing and brings home the reality of abstract topics like CO_2 concentrations.
- To use this engagement to launch community-driven action outside of the radio sphere, supporting activities in the 'real world' that follow on reported content.

Stakeholders

A summary of the stakeholders involved in the project is provided in Table 1.

Stakeholder	**Contribution**
Developing Radio Partners	Training, information and support to stations on how to report on climate change issues and engage listeners. Distributed field recorders and FrontlineSMS technology, held workshops for local radio staff and journalists, worked with radio presenters on content and delivery of stories with weekly bulletins. Organised workshop with permaculture specialists with field demonstrations (permaculture is an excellent way to mitigate climate change). Provided funds to stations for community events.
Open Society Institute	Provided funding for project.
Breeze FM	Breeze served as the base of operations for ZTL. Station staff here helped support other stations' staff, while also participating in workshops and training events. Organised public events to reinforce messages being shared in radio broadcasts.
Other Radio Stations	The other five stations also participated in training events and learned how to deliver effective, interactive reports on climate change issues specific to their communities. Organised community events.
Tribal Leaders / Local Government	In full support of the project, local formal government and tribal leaders helped spread awareness of ZTL, and helped organise and drive participation in community events supplementary to the information in broadcasts.
Local Farmers	The ultimate stakeholders in the success of this project, the local farmer communities received new information and participated in broadcasts and action events. The goal of the project was to help these communities realise the value of their surrounding forest communities, and also to learn about strategies to mitigate the danger of their stoves, among other lessons.

Table 1: *Zachilengedwe Tsogolo Lathu* Stakeholders

Impact: Cost and Benefits

The impact of the project was multifaceted. Radio not only brings information *to* people, but also is unique in fostering discussion *with* citizens and public officials to change behaviour and policy. The total budget for this was US$97,212. No costs were incurred for Frontline SMS, and the training was included in two workshops.

The benefits are many:

- Citizens are better informed about local climate change issues and actively participated in adaptation and mitigation strategies. For example, in Mchinji, Malawi, the local Community Oriented Development Programme (CODEP) held Action Events to supplement radio programming on deforestation and its impact on the climate. Action Events encouraged the community to collaborate with CODEP in the future, which also provided the community with seedling trees.
- Journalist capacity has improved, with previously amateur and volunteer radio presenters now having the skills to find and tell compelling stories on climate change issues. For example, at station Radio Mudzi Wathu, journalist Joseph Mazizi spoke to a small organisation called Total Land Care, where he learned about an inexpensive way to make more efficient stoves from local material—anthill soil, animal dung, and bricks—at little or no cost. Mazizi not only built a radio series on climate change and alternative energy sources around the initiative, but also worked with Total Land Care to demonstrate the stoves in person to local women and tribal leaders, many of whom began using the cleaner stoves (see Figure 2).
- Local stations and NGOs have begun working together to engage local government and tribal leaders on key climate issues. Early results indicate positive feedback, including a pledge from many local leaders to begin reforesting decimated forests.

Figure 2: Making a More-Efficient Cookstove at Radio Mudzi Wathu Community Event

Evaluation: Failure or Success

In light of the benefits identified (and also given relatively low cost), the project can be given an interim evaluation of success. Of course, the contribution to climate change mitigation and other changes around climate change adaptation and public health can only be judged in the long-term. But the long-term prospects for the project look good both technologically and institutionally.

Both local radio and mobile phones represent sustainable technologies. It must be acknowledged that – while mobile phone usage is widespread and growing throughout sub-Saharan Africa – at the very bottom of the pyramid, where these projects are targeted, usage is not yet as widespread. Literacy is also a major barrier to interaction using SMS, the most common way for radio stations to solicit feedback. However, as trends in mobile phone use continue, this will most likely become less of an issue in the future. Overall, the innovative use of mobile phones and text messaging with FrontlineSMS was considered a success by participating journalists, especially at Breeze FM, where the software is now used for all radio programmes, not just the environment and climate change programming included in the original project.

Institutionally, one can identify what is seen as the biggest success of the project: the close partnerships built between local environmental organisations and the newly empowered radio stations and their staff. These low-cost, strategic partnerships are an effective and sustainable way to continue raising awareness and engaging the community in climate change mitigation (and adaptation). This is in addition to the weekly half-hour environmental programmes aired by all the stations plus their community events.

Enablers/Critical Success Factors

One key to the success of this project was the **early and ongoing involvement of the participating community** itself. From naming the project at the very beginning, participants, many of whom worked as volunteers for tiny stations, had a real sense of ownership of the project, and their personal attachment was a key part of keeping them engaged and, in turn, getting their listeners engaged. There was also regular communication with all the radio stations – even those located far from the project central base – to ensure a continuous sharing of good practices and new ideas.

Technologically, the project has succeeded because it largely chose **to use existing technological infrastructure**. The radio and mobile phone infrastructures were already in place; the project merely sought to overlay new or improved application of that technology. Adding in FrontlineSMS and integrating mobile phones at a time when they were only just starting to become widespread meant the project did push the envelope to some extent, but not to such a degree that it became a 'bleeding-edge' project that fails due to technological over-ambition.

Strong, local institutional partners were important. Nodal partner Breeze-FM already had institutional capacity – this did not have to be built – including a professional staff eager to organise the workshops and provide mentoring and monitoring to the smaller stations. Within the communities too, there was a motivational capacity that did not have to be created: strong buy-in from local leaders and community organisations helped ensure the success of awareness-raising activities, which served to deepen listener engagement and enact the lessons of the programming.

The project management style can be described as one of "**clear destination but flexible routing**". The project team set and maintained clear goals from the beginning of the project. We focused our intervention on radio station staff, empowering them to go into their communities and work with local organisations, thereby ensuring the sustainability of those partnerships and connections. While keeping an eye on those goals, however, there was flexibility to cope with contingencies. For example, it emerged that many of the participating stations lacked key workable resources, from microphones and recorders to computers. Although these items were not originally budgeted, the leadership at DRP was flexible enough to find ways in which these tools could be provided.

Constraints/Challenges

Resource constraints – financial, human, technological – were and remain an ongoing challenge for local/community radio projects. Most radio stations in the area have almost no operating budget, meaning that journalists are often volunteers with little training, equipment is old and failing, and even station power fails routinely, making it difficult to schedule and promote regular segments.

Those resource constraints are themselves in part a symptom of broader **geographical and infrastructural constraints**. The project deliberately targeted remote, rural communities as those most in need of information and assistance. Yet this means that transportation and accessibility became significant hurdles to project implementation. Flooded roadways made it difficult to carry out regular observations at each station involved in the project. Further, radio journalists often could not get around to interview sources or do local reporting.

Recommendations/Lessons Learned

Build resources, build capacity for radio and climate change. Radio is a key and effective channel for climate change-relevant information that can reach very large numbers. But resources matter. Even though, technically, radio stations are widespread throughout even the most remote rural regions, they usually lack the resources and technology to effectively serve their communities as climate information hubs. Thus projects must ensure that financial support for stations and technical capacity building is a major component: otherwise the messages might never reach their audience.

Move beyond dissemination and interaction, to engagement and action. Radio has a great value in disseminating information and making listeners aware. Adding mobile telephony can turn this into an interactive process. But to have an impact on climate change, these informational processes must be turning into behavioural changes and action. This requires activities beyond ICTs, and projects should ensure that ongoing community events and even resources for citizen advocacy are part of their toolkit. More generally, ICT – particularly radio – projects must be prepared for the action implications of their work: in this case the radio reports had a surprisingly positive impact on the community, and the appetite for engagement outgrew the capacity of the project.

Keep technology "within the envelope". Don't push so far ahead with ICT innovations that you lose your project partners. Tools like FrontlineSMS are free and incredibly powerful, but one should not overestimate the technological capacity of journalists or the audience. Just introducing the technology and assuming it will be used effectively – or even used at all – will not work. Projects must ensure that technology training around any innovations is a major part of their capacity building.

Recognise the tension between value and challenges in remote, rural areas. Remote, rural areas are often those most affected by climate change. They are also most information-poor, and therefore the areas where ICT projects can bring the greatest value addition. Yet they are additionally – due to their resource and infrastructural constraints – the most challenging areas in which to implement ICTs-and-climate-change projects. Certainly working in far-flung rural regions will always pose more transportation challenges than you predict and projects should consider purchasing motorbikes to speed travel throughout coverage areas.

Data Sources & Further Information

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Data for this case study were obtained from personal observation of and participation in the project by Bill Siemering, the results of an independent evaluation conducted by Juliana Chileshe, and conversations with leaders of local organisations, including the Southern Alliance for Indigenous Resources, the Zambian National Farmers Union, and the Community Oriented Development Programme.

Further information can be found at:

- http://www.developingradiopartners.org/
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D2. Reducing Carbon Emissions through Videoconferencing: An Indian Case Study

Author: Debendra Kumar Mahalik

Initiative Overview

Globally, India ranks second in terms of population and among the five most-polluting nations, due to its size but also due to a relative lack of implemented initiatives to check and reduce carbon and other emissions (Parikh et al 2009, Lu et al 2011). The major emitters are construction and manufacturing, but the direct and indirect carbon emissions of the transport sector contribute around 14% of the total; a contribution that is forecast to rise inexorably in coming years (Singh 2006, Parikh et al 2009). The carbon emissions from transportation relate to both social and business uses and, within the latter category, some contribution occurs from travel relating to official government meetings.

Those meetings are an integral part of the functioning of government – to receive information about the current status of responsible areas; to make decisions including policy decisions; and to track the progress of decision implementation. Given India's large size – even within its individual states – many government meetings require attendees to be transported by carbon-emitted means. This case study outlines one initiative in Orissa state which sought to reduce the requirement to physically transport meeting attendees, by making use of information and communication technology in the form of videoconferencing (VC).

Application Description

Orissa is a state in eastern India, about 600km by 400km at its widest points with a population of around 41 million. It has 30 districts and the state capital at Bhubaneswar. The videoconferencing project provided VC capability in 32 locations – one "studio" for each of the district headquarters plus one for the Chief Minister, and one for the State Assembly. In each district, an air-conditioned room was identified near to the offices of the District Collector (the head official), and the facility was for use by any senior district officials. The Chief Minister's installation was for his sole use; the facility in the State Assembly was for other high-level state officials.

The videoconferencing facility was first begun in India in 1995; being the responsibility of the National Informatics Centre (NIC), a nodal agency of the central government, falling under the aegis of the Ministry of Communications & Information Technology. It was first installed in Orissa in 1998, and is now one of 490 VC locations managed by NIC.

As summarised in Figure 1, each of the studios has 10 to 12 person seating capacity, and they are ultimately connected out to the backbone network operated by NIC, which provides links not just to the other sites in Orissa but also to all NIC VC locations (for example, Chief Ministers in all other state capitals around the country). The backbone network typically operates via a 512kbps line but in some remote locations may use a 128kpbs line or satellite-based communication. The videoconferencing facilities in each studio are standard VC equipment – a camera, microphones and sound system to transmit data to other locations; a 42-inch LCD television to present data from other locations. The codec and decoder provide the software and hardware that convert the analogue audio-visual data into digital format for transmission, and vice versa for data from other locations. In addition, there is an electrical back-up facility in case of power cuts, and a stand-by line in case of problems with the main network connection (NIC n.d.). NIC utilises a multipoint conference server (MCS) which allows multiple sites to participate in a live videoconference and share both audio-visual and document data. It also allows either voice-activated and chairperson-controlled conferencing.

Locally, each studio is managed by staff from the State Informatics Office, who work in the districts. Users book sessions in advance and NIC lists a cost of Rs.3,000 (c.US$60 plus tax) per hour for a point-to-point meeting, with additional charges levied for multi-point meetings (ibid.).

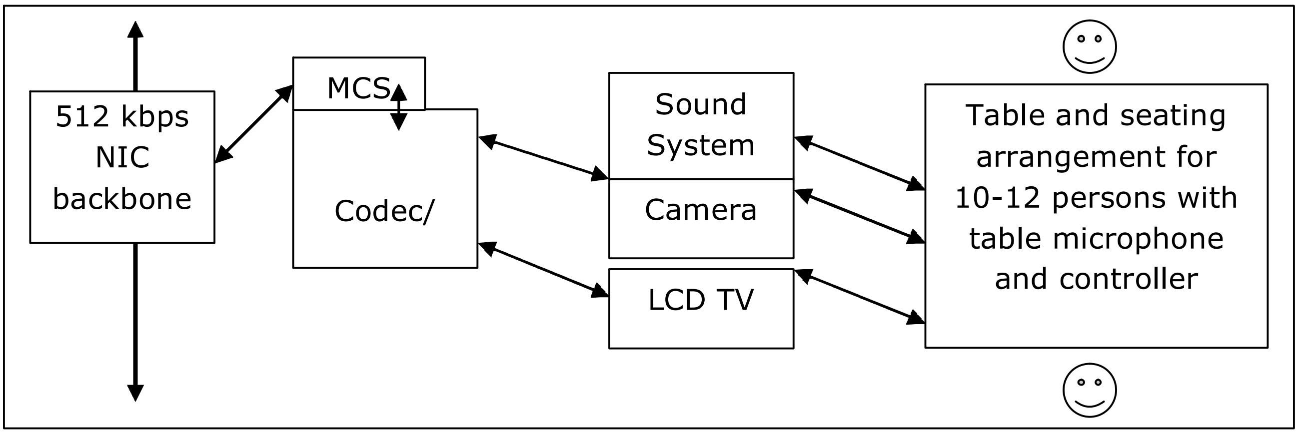

Figure 1: Orissa State Videoconferencing Studio

Formal Drivers and Objectives/Purpose for ICT Usage

The drive to install the videoconferencing facility came initially from the NIC itself, and was relatively techno-centric – a desire to demonstrate and extract value from NICNET, their cross-India network. Given that the installation was initially undertaken some years back, there was some recognition of the environmental value, but the rationale was more focused around savings of time and cost for those involved.

However, the potential environmental value of the application has come to be recognised more over time, as concerns about climate change have grown. To some extent, one can therefore see emissions-reduction as an emergent driver and purpose for this particular type of ICT usage.

As noted above, government officials must engage in discussions on a whole variety of issues, and this has traditionally been done by physically moving those decision-makers to a single location. Given India's rather centralised model of government decision-making, this has meant frequent car journeys for district officials to the state capital; a continuous source of CO_2 emissions given that district headquarters lie up to 400 km from Bhubaneswar. Hence, videoconferencing provides an alternative that can make some contribution to climate change mitigation by dispensing with the need for some journeys, allowing meetings to be held virtually.

Stakeholders

The main stakeholders are as outlined already. The key users are the Chief Minister and other high-level state officials such as ministers of particular state departments, and their equivalents at the district level including the District Collector. Other potential users include public services like courts, health, family welfare, etc. The system is managed and maintained by the National Informatics Centre and local-level IT staff within the state government.

Impact: Cost and Benefits

The videoconferencing facility is most definitely used (see Figure 2), as the following sample indicates:

- March 2011: Chief Minister directs all District Collectors via VC to electrify all villages in the state by 2012.
- May 2011: Chief Minister reviews progress of National Rural Employment Guarantee Scheme with District Collectors; also advises Collectors to attend to public complaints within certain specific time periods.
- June 2011: Chief Minister review and discusses specific departmental schemes with District Collectors.
- June 2011: Chief Minister discusses the impact of unseasonably-heavy rain with Collectors in particular affected districts.
- June 2011: Chief Secretary discusses and reviews Schemes for Traditional Forest Dwellers with all District Collectors.

In each of these cases, at least one car-full of personnel would otherwise have travelled from each district headquarters to Bhubaneswar.

Source: eOdisha.com (2011)

Figure 2: Chief Minister Videoconferencing

The financial cost of the VC facility can be calculated as shown in the following tables (sourced from discussions with NIC officials).

Item	Cost
VC equipment	Rs 800,000
LCD TV	Rs 60,000
Camera	Rs 10,000
Room furnishing	Rs 100,000
Other expenses	Rs 30,000
Total	*Rs 1,000,000*
US$ Total	***c.US$20,000***

Table 1: Videoconferencing Studio Installation Costs

Item	Cost
Technical support charge	Rs 10,000
Electricity and internet charges	Rs 80,000
Other contingency charges	Rs 10,000
Monthly Total	*Rs 100,000*
US$ Annual Total	***c.US$24,000***

Table 2: Videoconferencing Studio Running Costs per Month/Year

Given that there are 32 studios across the state, then we can estimate a total five-year installation and operational cost as: 32 x (US$20,000 + (5 x US$24,000)) = c.US$4.5 million.

Balanced against this, we can try to calculate the savings enabled by videoconferencing:

- On average, district headquarters are 250km from the state capital, thus requiring each District Collector to make a 500km round-trip in a diesel-powered, air-conditioned car per meeting.
- Based on the typical fuel consumption of the Ambassador and related cars used (c.12 km per litre) and the cost of petrol (c.Rs.70 per litre), then the fuel cost per round-trip would be around Rs.3,000. It is the norm to estimate that total transportation costs (i.e. wear and tear, maintenance, depreciation) add the same amount again as the fuel costs. To this one can also add the additional costs (not salary) of the driver for two days of Rs.1,000. This therefore provides a direct cost figure of around Rs.7,000 per visit. (Of course, there are also the time costs of having senior officials out of station plus also costs for food and lodging in state facilities)
- Multiplying this up for all 30 District Collectors, the direct costs per meeting are something like Rs.210,000 = US$4,200. It is likely that the indirect costs of time, lodging, etc at least double this figure; with a reasonable estimate being c.US$10,000 per meeting.

Figures provided by one of the District Collectors suggest that the pre-videoconferencing norm was for two visits per month to be undertaken to the state capital. Were all of these to be foregone, then the annual saving would be US$240,000.

Of course District Collectors still do go to the state capital from time to time, but – in addition – there are many other meetings by other government officials that are foregone due to use of the videoconferencing facility. Taking the past five years' data, an average of 25 meetings per month are held in each of the videoconference facilities. Were those each to attract the savings attributed to meetings of all District Collectors, then total cost savings of US$250,000 per month – US$3 million per year – would be attributable. In practice, not all the meetings by any means would have otherwise required a journey by all district collectors to the state capital – for example, there are VC discussions between the state capital and individual Collectors. However, there are also individual point-to-point discussions which mean that, state-wide, there are far more than just 25 VC meetings per month. Thus, while it is not possible to put an exact financial figure on videoconferencing, it is highly likely that the system far more than pays for itself in terms of the savings generated. (Noting that the financial flow means the state government is paying NIC typically around Rs5,000 (c.US$100) per meeting.)

Setting aside financial issues, the central concern of this case study is with climate change mitigation, and reduction in carbon emissions. Assuming that the cars driven are somewhere around the Euro-2 norms for emissions, that would indicate something like 200g/km of CO_2 emissions. Given each main meeting involves 30 trips averaging 500km each, then the per-meeting saving is 3,000kg of carbon dioxide. Very roughly (if we can assume the equivalent of five of these per month state-wide), then the VC system would lead to 180,000kg of carbon dioxide emissions per year (though the actual figure could vary quite a lot from this). (In addition, there would be 1,350kg of carbon monoxide, and 1,080kg of hydrocarbon particulates and NO_x emissions foregone.) It is very hard to estimate but, finally, we should also recognise the carbon emissions from the VC facility itself via electricity consumption, including the air-conditioning used in the rooms (though that should be balanced against the carbon costs of air-conditioning in the cars, which was not accounted in the calculations above).

Evaluation: Failure or Success

It must be recognised that there are large margins for error in the calculations provided above since exact figures are not available. However, it is certain that most videoconferencing meetings (assuming the alternative would have been a physical meeting rather than, say, email or a phone call) are contributing to climate change mitigation. They may do so only in a relatively small way but – if the assumptions above are close to correct – then videoconferencing in Orissa reduces carbon emissions by the equivalent of the CO_2 produced by a car travelling one million kilometres every year. (As noted above, the VC system may also save money for government, and reduces the emission of other pollutants.)

Figures show that usage of videoconferencing has been increasing over time. However, according to those interviewed, still only around five percent of total state meetings which could utilise videoconferencing do so. There is therefore great potential for future expansion, and for further climate change mitigation.

Enablers/Critical Success Factors

Fit of mitigation goals with other goals has helped to ensure the usage and degree of success of this project. If it was only related to mitigation goals, and those were the only benefits to be seen, it is unlikely the initiative would have succeeded. However, mitigation goals have been integrated into a broader picture – partly around formal goals (e.g. savings of time and money), and partly around less formally-stated goals (e.g. that NIC wishes to demonstrate the value of its ICT provision, that the Chief Minister is able to initiate meetings at short notice, that the district officials do find frequent travel to be tiresome).

Relatively simple, tried-and-trusted technology forms the foundation for the VC systems. As seen by the fact that the VC facilities have been running for more than ten years, this is far from cutting-edge ICT. But that is much to its advantage since there are fewer items to go wrong, and those that do can relatively quickly be fixed. For the meeting attendees, the simplicity of the technology make it relatively transparent: they can get on with their meetings without the need for extensive training, or for continuous technological interruptions.

Strong foundation of expertise is present, based in part on the National Informatics Centre team, which – as noted – has experience of rolling out videoconferencing throughout the country, and which has many years of familiarity with networking applications. And these are supplemented by the state informatics staff who by now also have expertise in dealing with the technology.

Constraints/Challenges

Motivational challenges to using videoconferencing still exist. In some cases district officials have multiple reasons for wanting to attend the state capital, and videoconferencing cannot substitute for all those. And on occasions – for example through concerns about security and privacy – officials wish to avail of face-to-face meetings, and videoconferencing is not seen as an option. Furthermore, while there has been encouragement to use VC – and the demonstrator effect of usage by the Chief Minister – there are no particular regulations, let alone mandatory requirements for its uptake. As a result, there is quite a gap between the number of meetings which could be undertaken by videoconference, and the number that actually are – thus the full potential for climate change mitigation has yet to be reached.

Limitations on awareness and technological infrastructure also impose constraints. On the first matter, VC usage is something like a members' club – once government officials have been first inducted, they become familiar with the process, and have a tendency to place VC into their mental map, and to make use of it on subsequent occasions. But there are many government officials still outside this "club" who are either unaware of the possibility of using VC or who – being unfamiliar and a bit uncertain – are unlikely to suggest it. This is exacerbated firstly by the association of usage of videoconferencing only with the highest-level officials, and by the relatively limited reach of VC: there are hundreds of sub-district (block and then panchayat) government offices that are outside the scope of this system. Again, then, the potential for climate change mitigation is substantially below what could be achieved.

Technological challenges also exist, though the main one is the challenge to this particular relatively high-cost studio set-up from lower-cost solutions; the most pervasive of which is Skype. In terms of climate change mitigation, though, use of Skype to substitute for journeys will help – further reducing carbon emissions.

Recommendations/Lessons Learned

Be ambitious in use of videoconferencing: whether in governments, private businesses or NGOs, staff spend a significant proportion of their time travelling to and from and attending physical meetings. All of this creates CO_2 emissions that could be mitigated. But this will only happen if organisations are ambitious in their use of videoconferencing. At present, and in part due to the use of high-cost studio-based VC approaches, videoconferencing has tended – as in Orissa – to be restricted to just a few senior members of staff. But this only touches the tip of the pyramid. To really make a significant impact on carbon emissions, organisations must be ambitious for VC – seeking to make it available to the widest possible range of staff.

Ensure maximum convenience of facilities: most likely staff only partially consider environmental issues when deciding how to undertake meetings; they are driven by habit, and also by their own personal costs and familiarities. All of this means that videoconferencing facilities must be as conveniently placed as possible – very close to their existing offices, and demand of them as few knowledge and time costs as possible – for example, ensuring there are dedicated staff to set up and operate the VC; leaving users just to conduct their meeting, and be as little aware as possible of the technology.

Recognise implications of technological innovations: the end point of maximum convenience and lowest cost is to place VC facilities on the individual user's desktop or laptop. In technological terms, this is readily achieved via use of a webcam and services such as Skype. Some users will require assistance to get such systems up and running, particularly to understand multi-point and multi-person videoconferencing. However, such systems should minimise costs.

Consider regulatory guidance: use of videoconferencing occurs not just because the systems are accessible with low costs, but also because there is a positive driver to use them. Making staff aware of the carbon emission and financial benefits can help, but humans are creatures of habit, and will still tend to arrange meetings. It may therefore be necessary to introduce some regulatory regime to encourage or require staff to undertake fewer journeys, and greater use of videoconferencing.

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D3. Mitigating ICT-Related Carbon Emissions: Using Renewable Energy to Power Base Stations in Africa's Mobile Telecommunications Sector

Author: Isabelle Gross

Initiative Overview

Although the ICT sector contributes only about 2% of global greenhouse gas (GHG) emissions[1], this is growing. One of the fastest-growing segments has been telecommunications: making up about one-third of the ICT sector's global carbon footprint[2]. And within telecommunications, no market has been growing faster than that in Africa: by 2011, the number of African mobile subscribers had passed the symbolic half-a-billion mark[3]. Continued high growth is anticipated, with average penetration rate for the continent still only 41% compared to 76% globally[4].

Such growth comes at an environmental cost. The adoption of mobile communication services in Africa means rollout of tens of thousands of base stations running on fossil fuels because so many parts of the continent lack reliable electricity supply. In DRC Congo, for example, 90% of Vodacom's base stations are powered solely by diesel generators, and across Africa, 90% of all base stations have a diesel generator either as the sole or backup source of power[5]. The number of off-grid, fossil-fuelled base stations is likely to rise steeply – with an estimated 75,000 being built per year in developing countries – since growth is particularly focused on rural areas: those least able to connect to the electricity grid[6]. The GSM Association thus forecasts there will be 640,000 off-grid base stations across the world by 2012[7].

Estimates of carbon footprint per mobile subscriber are certainly coming down as technology develops: first-generation networks produce around six times the CO_2 of third-generation networks[8]. Published figures vary quite considerably, in part depending on how much of the mobile lifecycle is included. One study reports 55kg of CO_2 per subscriber per year from operational outputs (and a further 13kg for mobile and base station manufacture)[9]. Multiplied up, that would suggest an annual carbon footprint for the African mobile telecommunications sector of 27.5 million metric tonnes of

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Mobile operator MTN provides figures for a selected list of African countries that are far below this: averaging 4.25kg CO2 per subscriber per year, but it is unclear what this includes: the African countries within its Carbon Disclosure Project Report are South Africa, Nigeria, Ghana, Uganda and Cameroon. These show variations from South Africa where the average annual emission of CO2 per mobile subscriber is reported as 0.29kg to Nigeria where the figure jumps to 6.9kg.

carbon dioxide, of which between 60% and 80% is estimated to come from running the base station network[10].

Leading telecoms operators working in Africa have pledged to reduce their CO_2 emissions. The Vodafone group has said for example that it would cut its emissions per network node in emerging markets by 20% by 2015 (from the 2010/11 baseline)[11]. The main approach to be used is renewable energy, and this case study therefore looks at renewable energy sources (solar and wind energy mainly) to power base stations in rural areas as an alternative to diesel generators. It uses examples of African mobile operators that have already successfully deployed such solutions on their networks.

Application Description

A base station (BTS: base transceiver station in full) is a tower or mast mounted with telecommunication equipment (e.g. antenna, radio receiver and transmitter at the top of the mast as shown in Figure 1) that enables the transmission of mobile signals (voice and data). At the bottom of each tower, there is a shelter with additional transmission equipment, air-conditioning, battery racks and – for those that are off-grid or with unreliable electricity supply – in a separate room, the diesel generator. The electricity consumption of a BTS is on average divided as follows: transmitters: 54%, air-conditioning: 35%, other equipment: 11%[12]. A typical BTS with a 4.8kW site load for example will consume 34 litres of diesel per day. On a yearly basis, this equates to more than 12,000 litres of diesel with an operating cost that can be double or triple that of an on-grid BTS according to the price of oil. In terms of emissions, this translates into an annual carbon footprint around 33.3 tonnes of CO_2[13]. The deployment of green energy solutions consists in replacing (partially or totally) the diesel generator by solar panels or a wind turbine as the main power supply of the BTS: see, for example, Figure 2.

Figure 1: Standard Mobile Base Station

Formal Drivers and Objectives/Purpose for ICT Usage

The drivers to roll out renewable energy-powered BTS are of two kinds, financial and environmental. At the mobile operator's group level[14], the emphasis is on climate change mitigation initiatives. Almost all mobile operators[15] have pledged to reduce the carbon footprint of their operations

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[14] Many mobile operations in the developing world, including many in Africa, are owned by large global telecommunications companies with group level headquarters – where all strategic decisions are made – in the global North. Examples include the Vodafone Group, Orange/FT, Telefonica, Millicom International, and MTN.

[15] The example of Vodafone was given above. Orange/FT is similarly committed to reduce its CO_2 footprint by 20% by 2020 on the basis of a 2006 baseline: Pike, A. (2010) How to evolve your radio network in an energy efficient way, workshop presentation, Bath, UK, 22-23 April

worldwide as part of broader corporate social and environmental responsibility strategies. These, in turn, are mainly driven by a mix of legislative and consumer pressures in industrialised country markets. With conversion of fossil-fuelled generators to solar/wind power in Africa helping reduce carbon footprints, these actions therefore contribute to the responsibility agenda.

At the country's operational level, the introduction of renewable energy solutions to power BTS enables operators to realise substantial savings on operating costs because they no longer incur the recurrent costs associated with the purchase and supply of diesel to power their BTS. It is not always clear which one of the two drivers – environmental or financial – matters more for mobile operators since the two become intertwined around the same strategy. One thing one can say is that environmental drivers come largely from outside the global South: in African countries, for example, there is rarely any regulatory framework on climate change issues, and mobile users' awareness on this topic remains very low.

Stakeholders

In Africa, most of the green energy-powered BTS projects are driven by mobile operators in partnership with renewable energy equipment manufacturers and solution providers. In Kenya, mobile operator Safaricom has worked with US-based wind power solutions provider Bergey at its BTS site in Laisamis located 200 miles North of Nairobi[16]. Mobile operator, Orange Côte d'Ivoire's solar base stations are powered by solar panels from manufacturer Tenesol[17]. On some projects, radio network equipment manufacturers (Ericsson, Huawei) and the GSM Association (as a funding and adviser partner) have also been involved. Public stakeholders (e.g. Ministry of Energy or telecoms regulators, let alone NGOs or consumer groups) are usually not involved in this type of project.

Impact: Cost and Benefits

When analysing the costs and benefits of implementing renewable energy solutions to power base stations, mobile operators look at capital expenditure (CAPEX) and operating expenditure (OPEX) and how long it will take (payback period) to recoup CAPEX by making OPEX savings. A study for mobile operator MTN on running 10 BTS in Uganda on solar energy indicates an average CAPEX around US$49,000 per BTS, annual savings of the order of US$15,000 and an average payback period of around three years, though with the latter figures varying depending on the price of diesel[18]. In Mozambique mobile operator Mcel has been replacing diesel generators with 100% solar powered systems on some of its sites. Up to 2010, it reports annual OPEX savings of US$405,000, with a CAPEX payback of around 12 months per site[19].

Some mobile operators extend the calculation of green energy benefits to include CO_2 reduction levels, thus linking their projects direct to climate change mitigation. The Mcel initiative just noted reports an overall annual saving over 5,000 tonnes of CO_2 by turning to solar power on several of its base stations. MTC, Namibia's largest mobile operator, swapped its diesel generator for a dual solar-wind power system in one pilot BTS which provides an annual saving of 4.58 tonnes CO_2 per year[20].

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[16] Bergey (2008) *Laisamis, Kenya*, Bergey Windpower, Norman, OK http://www.bergey.com/posts/2010/8/24/laisamis_kenya
[17] Tenesol (n.d.) *Off-Grid – Telecom*, Tenesol, La Tour de Salvagny http://www.tenesol.fr/fr/references/grid-telecom-orange-cote-divoire
[18] GSMA (2010) *MTN Uganda – Feasibility Study*, GSM Association, London http://gsmworld.com/documents/gpfm_mtn_feasibilitystudy_pages.pdf. Note that the actual load – i.e. the total energy consumption of the individual base station – will also affect the payback period.
[19] GSMA (2010a) *Global Mobile Award Winners 2010*, GSM Association, London http://www.globalmobileawards.com/gma11_oldcontent/history_from_backup/history/winners_2010.htm#cat_id15
[20] Milosevic (*ibid.*)

According to the GSM Association's green energy tracker[21] at the time of writing there were 666 renewable energy powered base stations in Africa. Almost all were solar-powered, though with a few running on wind, solar-wind hybrid, fuel cell or bio-fuel energy. African green BTS represent around 6% of the green base stations deployed worldwide (by far the largest number – more than 60% – are in China). African mobile operators have only just begun the process of swapping existing diesel-powered BTS and rolling out new BTS powered by renewable energy sources. So far out of the 55 African countries only eleven have green energy BTS, and the 666 base stations are a tiny proportion of the many tens of thousands that exist across the continent[22].

Evaluation: Failure or Success

When evaluating green BTS, there are not many failures as such but some projects did not work out as well as expected because they were either over- or under-dimensioned with regards to the power load of the BTS or did not have the correct meteorological data (particularly important for the implementation of wind-powered BTS). Mobile operators are gaining more knowledge and experience with each new project they implement and therefore there will be fewer technical glitches as time goes by.

As an example, by mid-2011, mobile operator Orange Côte d'Ivoire had rolled out 104 BTS sites powered by solar energy, mainly in rural areas (see Figure 2). It planned to roll out ten additional solar-powered sites per year until 2015, at which point renewable BTS would represent 15% of its total number of base stations[23].

Overall, the small proportion of green BTS within the total – well under 1% and possibly closer to 0.2% if GSMA figures are correct – means only a limited contribution to carbon mitigation; particularly considering the rapidity with which new BTS – including off-grid BTS – are being built. However, they do represent some contribution, with a verdict that something is better than nothing. If a significant dent is to be made in the telecommunications sector's CO2 emissions, then there will need to be a significant scaling up; something that will likely require involvement of other stakeholders including government, consumer groups, and international organisations.

Figure 2: Solar powered BTS – Côte d'Ivoire

[21] GSMA (2011) *Deployment Tracker*, GSM Association, London http://apps.wirelessintelligence.com/green-power/tracker/
[22] GSMA (2011: *ibid.*). As examples of numbers of base stations, Vodacom – with a 58% market share – had roughly 10,000 base stations in operation in South Africa in 2010: Vodacom (2010) *Vodacom Annual Report 2010*, Vodacom, Midrand, South Africa
http://vodacom.investoreports.com/vodacom_ar_2010/business-overview/technology-and-resources/; there were reported to be around 20,000 base stations in Nigeria in 2011: Nkanga, E. (2011) Nigeria, ICT devt will contribute to GDP growth, says minister, *This Day*, 1 Sept http://allafrica.com/stories/201109010866.html; and Mobinil – with a 43% market share – had 6,500 base stations in Egypt in 2008: Balancing Act (2008) Mobinil launches 3G services in Egypt, *Balancing Act*, 421, Sept. By comparison, India had an estimated 250,000-340,000 in 2010: Shah, B. (2010) *Cellular Base Stations*, Indian Institute of Forest Management, Bhopal, India & Chadha, M. (2010) Solar power cellphone towers in India to reduce 5 million tons CO_2 emissions, *Clean Technica*, 24 March. On that basis, one may estimate the total number of BTS in Africa in mid-2011 to be 150,000-350,000.
[23] The author's own conversation with a representative of mobile operator Orange Côte d'Ivoire.

Enablers/Critical Success Factors

A **positive cost/benefit equation** has been central to the roll-out of green BTS that has so far occurred. The financial aspects have been noted above, and the benefit side of the equation is further strengthened by the positive environmental reporting that telecoms firms can lay claim to as a result of their renewable energy investments.

One key to the extent of carbon mitigation is **choice of technology**. For example, using solar power in combination with a diesel generator for a hybrid system requires a lower level of capital investment but provides lower CO_2 savings (GSMA estimates 2,685 of these in addition to 10,245 green BTS worldwide in 2011)[24]. By contrast, a fully-green system using a combination of solar- and wind-based battery charging (a mix used by operators to guarantee 24/7 uptime since neither solar nor wind are 100% available) would minimise operating costs and maximise emissions reductions, but cost much more for capital investment.

Constraints/Challenges

As is perhaps reflected in the relatively limited extent of green BTS roll-out, the programme faces a number of important challenges:

- **Technical complexity and expertise constraints** create difficulties for the mobile operators[25]. Most African telecoms engineers are familiar with BTS powered by diesel generators because this is what they have been working with since the launch of mobile telephony. There is much less expertise available on renewable energy solutions in all areas: planning, implementation and maintenance.
- A number of renewable energy technologies face **generation challenges**. For instance – and somewhat ironically given the connection to climate change – there are meteorological limitations. By and large – in much of Africa – these do no relate to sunshine and solar power but to the right level of wind (not too much, not too little) for wind-powered system. In South Africa for example, only the southern coastline is well suited for wind power. Côte d'Ivoire has rather limited suitable sites compared to Senegal[26]. In addition, long-term availability of fuel sources for alternative technologies may be problematic. In 2006/07, Ericsson, MTN and the GSM Association undertook a bio-fuel pilot in Nigeria that established the operational feasibility of using it as an energy source for standard base stations. However, the pilot – and ideas of future expansion – was terminated because of the lack of bio-fuel availability within the country[27].
- **Eligibility constraints** mean that not all base stations are suitable for renewable energy systems: those with high loads (i.e. high power requirements) would need an unviably large space of solar panels (which generate relatively small amounts of electricity per panel), particularly where space is limited as in urban areas; and would require an unviably large investment cost, particularly as such stations would typically need multiple types of renewable energy.
- An emergent challenge has been that of **theft**. There have been problems with siphoning diesel from traditional off-grid BTS, but theft of solar panels, wind generators and batteries is also an issue[28]. For one African mobile operator, this had reached such proportions they were considering not rolling out any more solar-powered BTS.
- **Financing** the capital cost of green BTS is a further obstacle. Most renewable energy projects are financed entirely by mobile operators from their own internal funds. Not all operators in Africa necessarily have plentiful supplies of capital for investment in green projects. Even those with

[24] GSMA (2011: *ibid.*)
[25] Milosevic (*ibid.*)
[26] The author's own conversation with a representative of mobile operator Orange Côte d'Ivoire.
[27] ITRealms (2008) GSMA says Nigeria lacks biofuel feedstocks, *ITRealms Online*, 29 Oct http://itrealms.blogspot.com/2008/10/gsma-says-nigeria-lacks-biofuel.html
[28] Milosevic (*ibid.*)

capital still have to choose between competing infrastructure investments. So for example why would a mobile operator invest in renewable energy projects (offering a long term saving) when more 3G base stations are needed (increasing revenue prospects in the short term)?

- Beside financial considerations – and reflected in their financial decision-making – the **mindset** of mobile operators remains the biggest challenge. They have a negative perception about the reliability of renewable energy solutions (e.g. the BTS will go down if there is no wind!) compared to the old and well-known diesel solutions and a risk aversion to technologies that they have yet to completely master.

Recommendations/Lessons Learned

For most African countries, the central issue is resolution of the chronic deficit in electricity production. However, this is not an excuse to put aside the issue of climate change. Mobile operators – at the heart of the telecommunications success story in Africa – have shown some interest by piloting projects that reduce carbon emissions and enable them to operate in a more environmentally sustainable way. But the scale of deployment of green BTS in Africa is yet too small to have any significant impact on climate change. The challenge that lies ahead of them is to scale up to a level where these new technologies will have a real climate impact.

Identifying pressure points will be important in understanding what will drive the operators to take more widespread action. As noted, the main environmental pressures have so far come from outside Africa, and there needs to be more effort to identify and build local environmental drivers. One impact of this absence has been a disjuncture between the global and the local: carbon mitigation is a top-down strategy coming from group level headquarters in the global North; by contrast national operational priorities are often for network expansion, with green BTS having to fight their case alongside many other priorities. With the environmental agenda being seen as top-down and externally-driven, this has limited the participation of local stakeholders – employees, customers, government, civil society – in a debate about ICTs and climate change.

Greater sharing of knowledge and expertise is required. The GSM Association has been an important clearinghouse, but there still seems to be too little known within national operators in Africa about the specifics of planning and implementing green BTS solutions. This partly explains the very limited percentage of BTS in Africa converted to renewable energy; and Africa's small share of global green BTS. Greater sharing of information and knowledge – including sharing between operators and renewable energy suppliers – may also slowly help to change operators' mindsets, and make green BTS more of a norm rather than an exception.

A **greater variety of funding sources** is needed; particularly dedicated sources where operators are not faced with the opportunity costs that often, to them, look like "be bigger or be greener". Government incentives for renewable energy could help; as could tapping into broader initiatives. For example, in 2011, South Africa's Nedbank Capital launched a carbon credit-related initiative for African telecom operators[29]. It allowed the operators to access global carbon credit markets (without having to understand the complexities of those markets and regulations), and thus earn additional income from providing renewable power sources for their base stations. It is possible that public-private partnerships might have some role to play, but direct action by government can also help. Again in 2011, the Senegalese government announced it would use its ICT universal access fund to invest in energy saving projects[30]. Although not directly linked to base station power, it is clear that the potential exists to use universal access funds in this manner.

[29] Milosevic (*ibid.*)
[30] Dabo, B. (2011) Fonds de soutien de l'energie du Plan Takkal, *Reussir*, 5 Mar http://www.reussirbusiness.com/12763-FONDS-DE-SOUTIEN-DE-L-ENERGIE-DU.html

Data Sources & Further Information

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Data for this case study was gathered by the author through contacts with mobile operators in Africa, and as part of writing an earlier paper in 2011: *Energy for Cellular Base Stations in Africa* - http://www.balancingact-africa.com/reports/telecoms-and-interne/energy-for-cellular

Another source of further information are the Green Power for Mobile reports produced by the GSM Association: http://www.gsma.com/our-work/mobile_planet/green_power_for_mobile/resources.htm

Part E: Case Studies of *ICTs and Climate Change Monitoring*

E1. ICT-Based Monitoring of Climate Change-Related Deforestation: The Case of INPE in the Brazilian Amazon

Author: Raoni Rajão

Initiative Overview

Deforestation is one of the main sources of greenhouse gases; accounting for at least two-thirds of Brazil's emissions (Greenpeace 2011). PRODES and DETER are two satellite-based monitoring systems used for policy-making and law enforcement in the Brazilian Amazon which aim to curb deforestation and, hence, reduce emissions. Over the years the information from these systems has provided a key common ground for policy debates between agencies of the Brazilian government, environmental NGOs and scientists, thus helping the efforts to track and address climate change. The case study of these systems emphasises the role of continuous political support, negotiation and transparency in the successful development of information and communication technologies (ICTs) for the monitoring of climate change.

Application Description

PRODES (program for calculating deforestation in the Amazon) was initially created in 1988 by the Brazilian Institute for Space Research (INPE). The origins of the system can be traced back to the decision of the military government in the late 1960s to invest in remote sensing technology. Following this initial investment INPE became over the years a world-class research institute in the detection of natural resources and land-use change using advanced ICT.

PRODES has been designed to produce a yearly estimate of the total area of forest loss in square kilometres, and the breakdown of this figure to the nine states of the Brazilian portion of the Amazon. In order to enhance transparency, from 2003 onwards INPE started to publish online not only the aggregated figures but also the detailed map of deforestation indicating the location of individual clearings.

Broadly speaking (see Figure 1), PRODES detects deforestation based on satellite images captured through the US Landsat and the Chinese-Brazilian CBERS satellites, which are then processed by computer algorithms and interpreted by a local team of technicians and scientists. Following this process PRODES generates a georeferenced map for the whole Amazon with individual polygons indicating the location of deforestation.

Building upon a similar technological and knowledge base, in 2004 INPE developed DETER (deforestation detection in real time), a satellite-based monitoring system that detects deforestation every 15 days and provides monthly estimates from images obtained from sensors on board US satellites Terra and Acqua (see also Figure 1).

Today PRODES and DETER are used intensively by different groups inside and outside the government. PRODES, given its reliability and comparability over more than 20 years, is still the main system used for debating major policy changes following the release of its yearly data. DETER, on the other hand, is used mainly to evaluate the outcome of actions on a monthly basis and guide law enforcement actions in the forest.

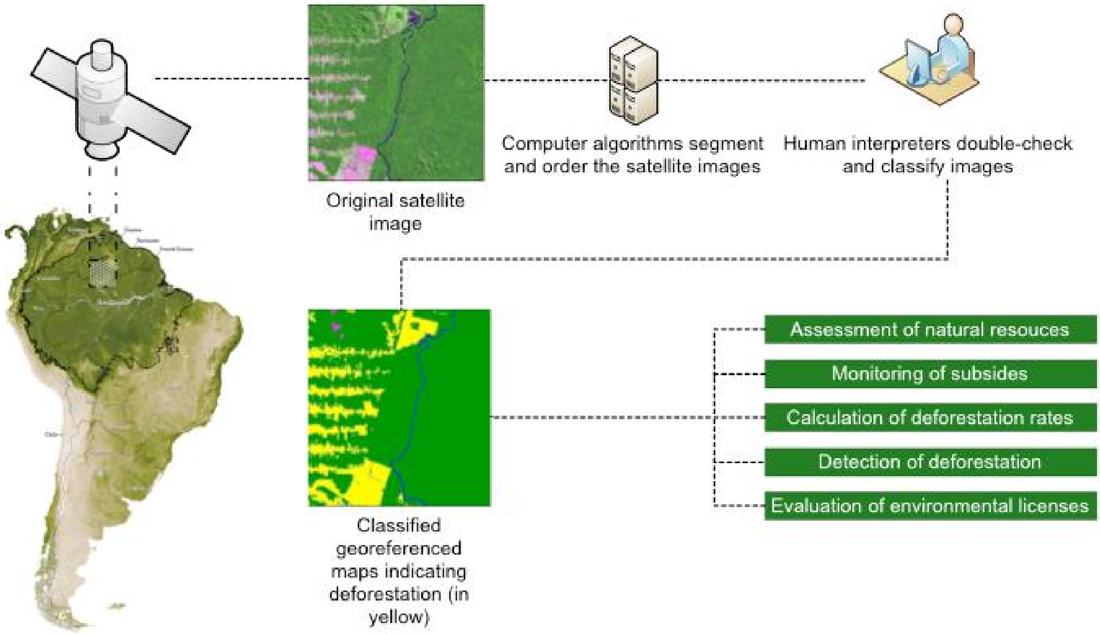

Figure 1: Schematic Representation of the Functioning of PRODES and DETER (Rajão and Hayes, 2009)

Drivers and Purposes

One of the main causes of climate change is the increasing level of greenhouse gases in the planet's atmosphere. While most greenhouse gas emissions are produced by the generation of electricity and production of industrial goods, deforestation (and related activities) contribute around 17% of global emissions (IPCC 2007). In Brazil the proportion of greenhouse gas emissions from deforestation is even more substantial. Here the destruction of the Amazon and other biome represents three-quarters of the country's carbon emissions placing it as the fourth-largest emitting economy (Greenpeace 2011). For this reason there is a growing consensus among scientists and policy-makers in Brazil and abroad that the reduction of ongoing forest loss in the region is a key element of any successful global strategy to tackle climate change.

Monitoring systems based on advanced ICT play a key role in tackling climate change by allowing policy makers and other policy stakeholders to make informed choices about strategies to curb greenhouse emissions. But in order for a monitoring system to be useful in policy making it has to be accepted as trustworthy by the different groups involved. Since the mid 1970s INPE has produced deforestation assessments of the Amazon using advanced satellite technology, but this initial period was marked by an intense debate between scientists, environmentalists and politicians concerning the correct figures for the total deforestation in the Brazilian Amazon.

As a consequence of this lack of agreement the key policy issues in the region were often overshadowed by mutual accusations on basic points such as whether deforestation was under control or increasing due to impact of colonisation policies in the region (policies which encouraged conversion of Amazon forest into farming land). An example of this issue took place in the mid-1980s when the Brazilian government discredited scientists' concerns over the growing speed of deforestation (e.g.

Fearnside 1982) and approved substantial colonisation projects in the Amazon (Hecht & Alexander 1989). It was only after 1988, with the creation of PRODES and a long process of negotiation, that the government had at its disposal widely accepted yearly deforestation figures produced using a consistent and accepted methodology.

One can therefore see the main internal drivers to these projects as partly political, partly informational, with the central purpose being to produce agreed deforestation data. But, in addition, there were external drivers. According to senior scientists and politicians, PRODES also emerged as a reaction to the publication of deforestation projections that led the World Bank to freeze the payment of loans to Brazil. In order to counter these projections the central government requested INPE to produce yearly deforestation estimates based on actual observations of land-use change from satellite images.

Stakeholders

The initial development of PRODES involved senior officials and politicians from the federal government and INPE scientists. During the 1990s and 2000s, however, scientists from other institutes and members from environmental NGOs also started to use PRODES and contribute to its development. These contributions included, for instance, the successful lobbying for the publication of the full deforestation maps on the Internet rather than only the final deforestation figures. With the creation of DETER in 2004 forest rangers from the federal and state-level environmental agencies – particularly from IBAMA, the enforcement agency of the federal Ministry of Environment – then started using INPE’s monitoring systems.

Impact: Costs and Benefits

It is possible to identify impacts stemming from the development of PRODES and DETER on different fronts. Thanks to the development of PRODES during the 1990s the earlier antagonism between scientists inside and outside INPE has become a fruitful collaboration. During this period INPE scientists carried out research with some of the scientists that have previously criticised their work, and have integrated in their deforestation detection methodology some of the latter's suggestions. These suggestions included, for instance, the consideration of deforestation prior to the 1970s and the related revision of the total deforestation figure within PRODES.

Furthermore it was possible to see a gradual construction of trust around PRODES as its deforestation figures started to converge with independent studies and its data started to feature more frequently in academic publications and policy reports. With the publication online of PRODES deforestation maps in 2003 and the creation of DETER in 2004 the reputation of INPE as a trustworthy and transparent institution was further strengthened. This trajectory suggests that the continuous investments made by the Brazilian government in satellite technology, its transparency about data sources and calculations, and its openness to negotiation have contributed to a process of capacity building that places Brazil as one of the leading nations in satellite-based deforestation monitoring (Kintisch 2007, Stern 2007).

Today INPE’s monitoring systems play a central role in different activities of governmental and non-governmental organisations. Governmental officials, members of environmental NGOs and scientists often use INPE’s data as a "taken-for-granted" base to debate policy alternatives and evaluate the outcome of previous actions. Furthermore, given the open access policy adopted by INPE, an increasing number of NGOs and academic institutions are using detailed deforestation data to provide their own policy analysis, and from that offer advice to the government. It is thus possible to trace a relation between hikes in deforestation rates detected by PRODES and DETER and key policy changes. These include the increase in the legal reserve (the compulsory portion of preserved land within total private lands) in the Amazon from 50 to 80% in 1996; the creation of the plan to protect and control deforestation in the Amazon (PPCDAM) in 2004; the creation of decree 6321/2007 limiting bank credit to farmers in the region; and the expansion of protected areas.

As noted above, from 2004 and the advent of DETER, an increasing number of forest rangers have also adopted this technology for frontline enforcement of deforestation control policies in the Amazon. This has not worked completely smoothly. The "real-time" logic of DETER has not matched well with the logic of work on the ground. The design assumptions within DETER are that rangers would go to an area of deforestation immediately the system detected it. But rangers pointed out that, in reality, due to the low resolution of DETER images, the long distances to be travelled, often poor road conditions, outbreaks of rural violence and limited numbers of rangers, they usually wait until deforestation in a given area accumulates to a certain level and better satellite images are available before it is worth sending in a team of rangers. So instead of using the GIS in real-time, as envisioned by system designers, the rangers may take months to visit an incidence of deforestation pinpointed by the system and issue fines. Nonetheless, in general, the use of technology has clearly improved their ability to identify and prosecute farmers that clear their lands illegally (see Figure 2).

Figure 2: Forest Ranger using DETER and a GPS Device in order to Prosecute Illegal Deforestation in the Amazon (picture by Raoni Rajão, 2009)

There is evidence that some of the policies and law enforcement practices enabled by INPE's monitoring systems have led to reductions in deforestation. Between 2004 and 2010 there was a substantial increase in the number of fines for illegal deforestation in the region. During this same period, annual losses to deforestation fell from 27,000 square kilometres per year to less than 6,500 (Phillips 2011). These both suggest improvements in the governance of the Amazon. Furthermore, according to Soares-Filho *et al.* (2010) the expansion of protected areas up to 54% of the remaining forest was responsible for 37% of the region's total reduction in deforestation. INPE's annual budget for research and development of satellites – among other activities – is approximately US$120 million. Even though it is not possible to assess the benefits of PRODES and DETER without undertaking complex and often controversial calculations of the cost of alternative scenarios, it is reasonable to assert that the benefits of INPE's ICT were much greater than the financial costs involved.

Evaluation: Failure or Success

If we consider the wide acceptance of these systems in policy-making in the Amazon and the related reductions in deforestation, it is clear that the development of PRODES and DETER has been a success. It is therefore reasonable to argue that these monitoring systems have helped tackle climate change in significant ways.

Nonetheless, one can identify some issues that require future attention. In particular, given their wide acceptance across different groups, the data produced by INPE has often become the main baseline for discussing policies in the Amazon. This focus, by its turn, has decreased the importance of the participation of other groups (e.g. indigenous populations and farmers) and other types of data (e.g. ethnographies, local accounts) in the formulation of policies.

Finally, it was possible to observe that INPE's monitoring systems have been the victim of their own success. The relation between the development of INPE's monitoring systems and reductions in deforestation have led some authors and policy-makers to believe that these technological artefacts can deterministically reduce deforestation in the region. This belief, in turn, ignores the ways in which this technology may be reshaped to fulfil the interests of different groups over time. Furthermore, given the focus on technology, some important groups – such as IBAMA forest rangers – have had their voices largely ignored in the development of new systems. While these issues do not compromise the merits of INPE they suggest that in order to ensure the long-term usefulness of PRODES and DETER the Brazilian government will need to change some of its practices.

Enablers/Critical Success Factors

Continuous political support. INPE is above all an academic institute producing world-class research on remote sensing. Thanks to continuous political support from the central government that invested in the institution for more than four decades INPE has been able to maintain a position that is at the same time close to the scientific community but also distant from the specific political struggles involving the data it produces. In this way INPE has been able to avoid the conflicts of interests that may emerge when the same agency that develops the information system is also the one responsible for tackling climate change.

Openness to negotiation and information system adaptation. It is difficult to establish what would have happened if INPE had not accepted the various information system design suggestions from the scientific community in the early 1990s. But one can hypothesise that the ability of INPE to negotiate and collaborate with the broader academic community and, more recently, environmental NGOs – and to incorporate their ideas into its own functioning – has been crucial for the establishment of its information system as a widely accepted base for the formulation of policies in the Amazon. In particular, it appears that the ability of some scientists from INPE to engage with and hear the concerns of the broader scientific community, and more recently the willingness of some politicians to bring the voices of environmental NGOs to the centre-stage of policy-making have proven to be important enablers for the success of this ICT initiative. Negotiation throughout the information system lifecycle has therefore been critical: in planning the information system, in producing the information, and in using that information for decision-making purposes.

Data transparency. The increasing transparency of its monitoring systems also played an important role in INPE's success. In particular, the publication of PRODES and DETER deforestation data on the Internet not only increased the trust in INPE's work but also allowed other groups, such as environmental NGOs, to make their own independent analysis and provide policy advice.

Constraints/Challenges

Absence of key voices from system design. While INPE and the central government have successfully engaged with environmental NGOs and the scientific community, other important groups are still left at the margins. As noted above, forest rangers did not find the real-time provision of data by the DETER system to be particularly valuable. Rather than needing more timely deforestation data, forest rangers demanded in their interviews and informal conversations satellite images with higher resolution, better integration between the GIS and other government databases (such as taxes, ordnance survey, land registry), more training and improved working conditions in order to carry out their work. But the INPE scientists who design the system insisted that feedback from users is unnecessary for the development of better systems.

Recommendations/Lessons Learned

It is possible to identify three main lessons that emerge from the case study. By taking into consideration these lessons it is possible to make some recommendations to other countries on how to develop successful ICT for the monitoring of climate change.

Ensure information provision connects to decision making and action. Information is only of formal value if turned into decisions and then actions. One may argue, then, that the great success of INPE is not so much its provision of climate change-relevant information, but the uptake and use of that information by an eco-system of other organisations both inside and outside government. The design and operation of ICT-enabled climate change monitoring systems must therefore incorporate a clear understanding of how the information produced by those systems will be utilised, and by whom.

Separate information provision responsibilities from decision-making responsibilities. Cross-sectoral political support has made it possible for INPE to grow trusted, professionalised, scientific capacity for provision of ICT-based monitoring of climate change. Such support comes more readily if the responsibilities for such information provision are separated from the responsibilities for then using that information to make and implement both policy decisions (as in the case of the Ministry of Environment) and tactical decisions (as in the case of the forest rangers). Such a separation should be considered in the formation of organisational structures for climate change monitoring.

Make data freely available. This case study suggests that the importance of ICT for the monitoring of climate change lies not just in the final information output of these systems. It also lies in their ability to open up the raw data for use by other organisations. This would include double-checking of the aggregated figures, but also re-use of the data for other types of analysis. INPE's experience suggests that the use of open access channels, such as the Internet, is an important factor in creating the broadest possible value from this type of ICT-based system.

Find ways to close design—reality gaps. Forest rangers find difficulties in using the DETER system because, at root, there is too large a gap between the assumptions built into the system design, and the on-the-ground realities that they face. In other words, too large a design—reality gap. Closing such gaps for ICT-based climate change monitoring systems will be an important route to greater success for such systems. One key pre-condition for this gap closure is that system designers and developers should pay more attention to the way in which their technologies are actually used in reality, and should accept those who use their system – who may be relatively low in organisational rank – as legitimate voices who can make contributions of value to the improvement of climate change information systems.

Data Sources & Further Information

The case study presented above is based mainly on primary data collected by Raoni Rajão (Universidade Federal de Minas Gerais, Belo Horizonte, Brazil raoniguerra@gmail.com) in Brazil between June and August 2007, and between September 2008 and August 2009. During these two periods 85 semi-structured interviews were conducted with politicians (including three ex-ministers of the environment), senior scientists from INPE, and officials from IBAMA, among other groups. Moreover governmental documents spanning the last four decades and direct and participant observations of practices also played an important role in the constitution of the case study. Rajão and Hayes (2009) provides a more detailed discussion of the relation between INPE's monitoring systems and the institutional context of the Brazilian government. Hayes and Rajão (2011) offers a discussion of the relation between INPE's monitoring systems and sustainable development; an issue that is closely related to tackling climate change.

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E2. Improving Access to Mapping, Modelling and Scenario-Building Technology in Climate-Vulnerable Regions: Learning from *ClimSAT*

Author: Karen Anderton

Initiative Overview

In 2008 a partnership between the regional government of Brittany and UNDP, established a climate science and technology hub in Brest, France: ClimSAT. It was initiated with the primary aim of improving access to information on the impacts of climate change for some of the most vulnerable areas in the developing world. Promising and established state-of-the-art technologies, particularly in satellite imagery, were gathered in Brest and data gathered was then shared with other partners including regional governments in Indonesia, Senegal and Uruguay. The aim was to enable governments and communities to monitor and model the effects of climate change, and to base climate change and development strategies on accurate, location-specific information. ClimSAT was a concrete example of the increased action regional governments are taking to address climate change. ClimSAT in its original form ceased operation in mid-2011 but was integrated into a wider UNEP programme, the Territorial Approach to Global Change, Scientific Services and Knowledge (TASK). This case study sets out to learn from the experiences of ClimSAT.

Application Description

There were three main components of a ClimSAT project: data gathering, data processing (and storage), and data dissemination. Figure 1 outlines these and they are explained further below.

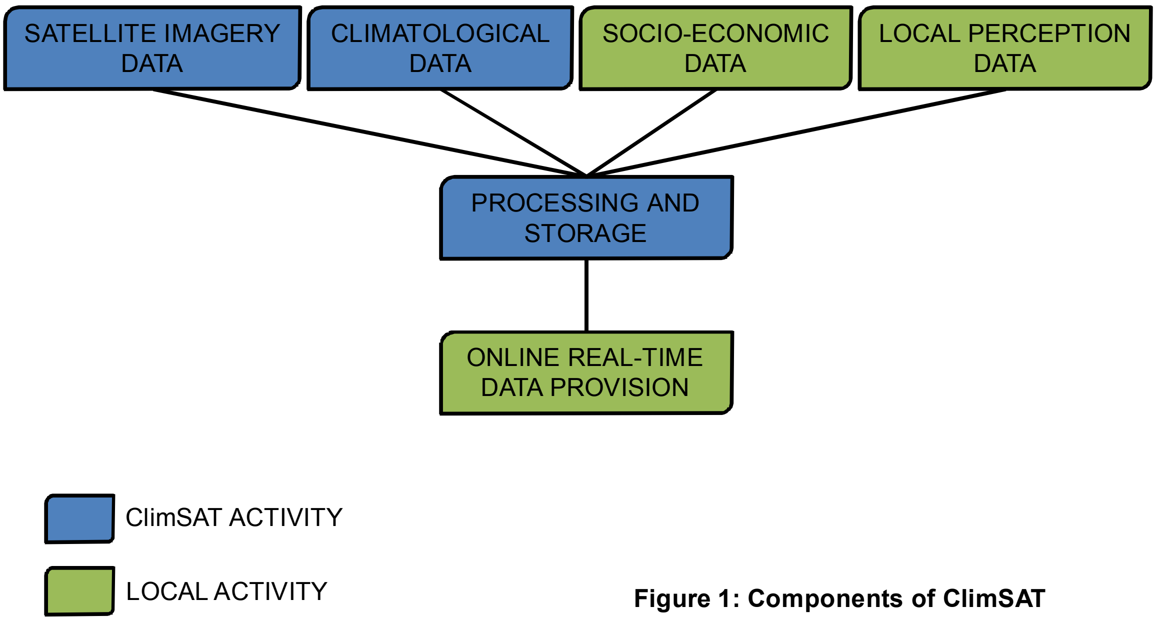

Figure 1: Components of ClimSAT

Data gathering
Four types of data were gathered for any region participating in a ClimSAT initiative:

- Satellite imagery data: regional information was purchased (and/or downloaded) from Space Agencies or partner satellite data providers.
- Climatologic data: historical series were gathered from the US-based National Oceanic and Atmospheric Administration (NOAA) and/or the European Centre for Medium-Range Weather Forecasts (ECMWF).
- Socio-economic data: gathered from local sources by local ClimSAT representatives.
- Perception data: obtained through field surveys conducted by local field teams, with ClimSAT guidance.

Data processing
Data processing was carried out by the ClimSAT team at the l'Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER) in Brittany. In particular, the climatologic data for a particular region was reprocessed and downscaled to make it more relevant and usable. The IFREMER supercomputer then processed future scenarios using the historical data gathered, against scientifically-accepted, global standard climate models (known as general circulation models) stored at Berkeley University. This process delivered detailed indicative information on the likely future risks of climate change, specific to each region.

Data dissemination
The real-time data stored at IFREMER was shared with each participating region via the internet. Each project was created by a local counterpart team that was invited for training in Brittany, to enable them to use the technology and make best use of the data. Once the skills had been shared, this team could then use the data autonomously under the remote guidance of the ClimSAT team in Brittany.

(Training covered theoretical modules on meteorology, climatology and oceanography; remote sensing and geographic information systems (GIS); complex systems modelling; and adaptive, energy and mitigation strategies and policies. There was also training on participatory approaches to climate change at the local level, and practical "hands on" training in remote sensing and GIS.)

Formal Drivers

Some of the participating Southern regions were amongst the poorest and most climate-vulnerable areas on the planet – they stand to face the worse consequences of climate change, but are the most ill-equipped to manage. ClimSAT offered an ICT-based platform to remove these significant barriers.

Providing state-of-the-art modelling and impact assessment tools to allow these regions to map and plan for likely future changes – including flooding from sea level rise, deforestation, desertification and changing rainfall patterns – was identified as a particularly strong driver for developing ClimSAT. Allowing developing regions greater access to information and communication technologies that will improve their resilience to climate change was the primary motivation for ClimSAT, through sharing technical capacity, expertise and location-specific impact analysis.

Objectives/Purpose for ICT Usage

The main objective of ClimSAT was to enable climate adaptation plans to better account for location-specific impacts, to better integrate knowledge of future impact into development planning, and to ensure that scenarios were robust by informing them with detailed research of a given area. Pooling resources – expertise, mapping and modelling technologies – was also an important objective.

The ClimSAT hub provided participating regions access to, processing and storage of data and expertise which could greatly enhance their ability to plan for development and adaptation with climate change in mind. ClimSAT's technology provided cutting-edge modelling and incredibly detailed data analysis to regions that do not have the capacity to access and utilise this information alone, due to their financial and skills-based limitations. It also got a network of leading computer and climate scientists to share their skills with participating partners, so that the latter were empowered to use this data in policymaking and strategy building.

Moreover, training local stakeholders in participating developing countries aimed to ensure not only knowledge transfer but also growth in the pool of international actors with knowledge of climate modelling and of utilising impact assessment tools. This, in turn, contributed to the future development of next-generation techniques – promoting collaboration which flows both ways, not just from North to South.

Stakeholders

Figure 2 explains the overall stakeholders involved in ClimSAT and their roles (in brackets) while Table 1 provides a list of the regional government partners.

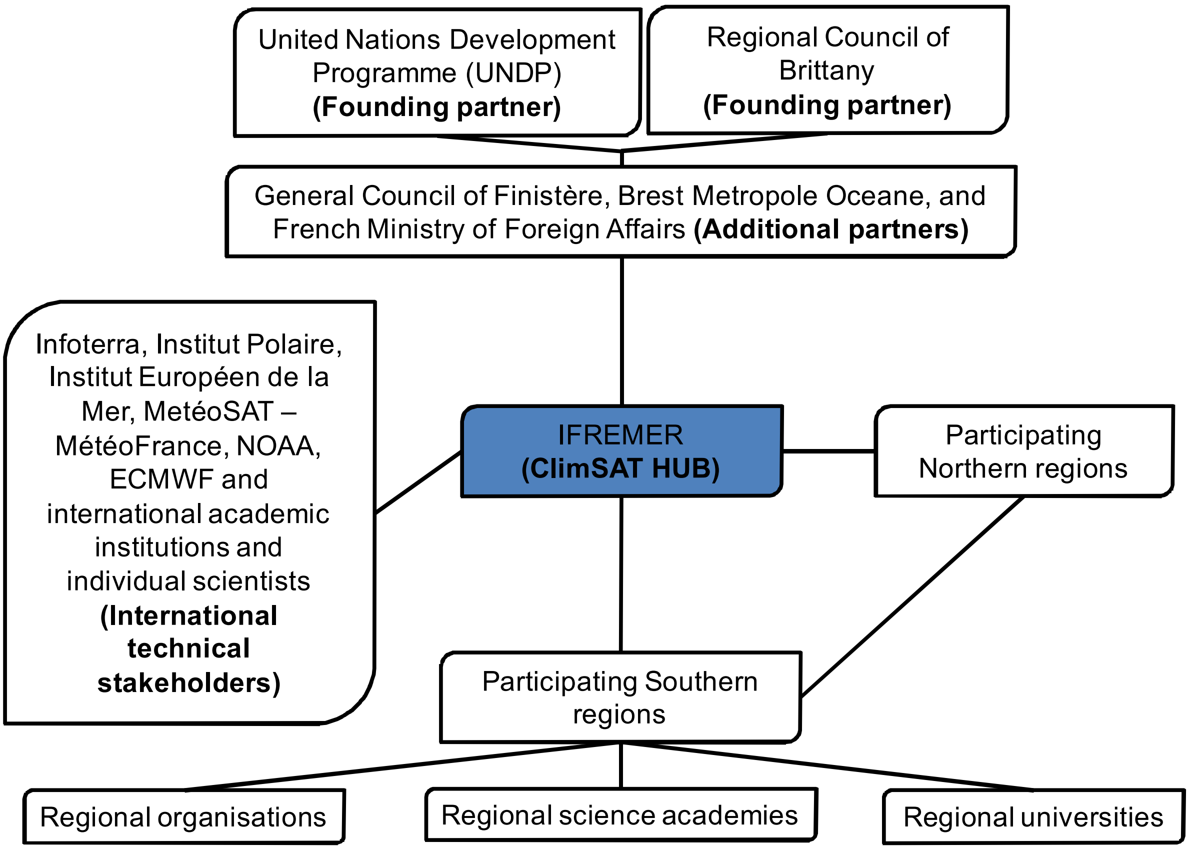

Figure 2: ClimSAT Stakeholders

The founding partners had responsibility for the initiative and for the work on-going at the IFREMER Hub in Brest. The technical stakeholders fed data and expertise into each project – many offered this support in kind. The additional partners have offered technical, political and in some cases financial support to the initiative.

Southern Project Regions	***Northern Partners***
Montevideo Metropolitan Area, Uruguay	Basque Country, Spain
Fatick and Ferlo, Senegal	Région Poitou-Charentes, France
Jakarta, East Kalimantan and Sumatra, Indonesia	Cataluña, Spain
	Wallonie, Belgium
	Piemonte, Italy
Other Southern Regions	***Other Northern Regions***
M'Bale, Uganda	Wales, UK
Cundinamarca, Colombia	Quebec, Canada
	Rhône-Alpes, France

Table 1: ClimSAT Partner Regions

Some of the Southern regions also had access to a Northern region partner. The latter's role was to offer financial and political support to their participating partner. The Southern regions were the focal point of the initiative, with the main objective for Northern partners being to facilitate data gathering and usage in the developing country. However, participation for the Northern regions also offered important learning experiences. Two-way knowledge transfer was an important outcome of ClimSAT.

Impact: Cost and Benefits

ClimSAT's initial ambition was to reach out to 50 global communities. Unfortunately, its budget fell some way short of what was needed for this. For example, in 2011 the annual budget for the programme was €880K, derived from the following sources: regional funds: €280K; UNDP (including Territorial Approach to Climate Change Programme): €140K; private funding: €210K; other sources: €250K.

As a result, projects only commenced in six countries – Uruguay, Colombia, Nicaragua, Morocco, Indonesia, Senegal. Some potential Northern partners perceived the projects as “Brittany’s” and were reluctant to commit financial resources to it. Given the financial crisis of 2008, investment for tools such as “ClimSAT” has been seen as non-essential, and therefore the programme struggled to find sufficient resources to operate at scale.

Support was provided for one full time centre Director, via UNDP and but it otherwise varied between individual projects. In Montevideo for example, two full-time posts were financed, which were based at the Ministry for Environment.

Many individual scientists involved in ClimSAT offered their expertise in-kind to the initiative, which was a substantial benefit and cost saving to the programme. Services offered by participating scholars included climatology, environmental modelling, economic analysis, anthropology and cognitive sociology. And while each individual project involved gathering of specific data, and mapping and monitoring specific impacts, the supercomputer and other technical resources in Brest only needed to be set up once, with just one initial outlay.

On reflection, given the limited rollout of ClimSAT and the long term nature of the impact over which the programme was trying to have influence, it is difficult to assess the direct and indirect benefits. While financial benefits and cost savings if models and recommendations are implemented could be large, there is no information about the level of uptake that ClimSAT recommendations generated. Furthermore, if through ClimSAT findings territories become more resilient to natural disasters, then cost savings are likely to accrue, but again it would be difficult to attribute this directly and solely to ClimSAT.

Evaluation: Failure or Success

ClimSAT can be seen as partially successful. At its outset, the programme was expected to be much larger and ambitious targets to engage regions internationally were set. There has however, only been limited implementation – as noted, only six projects were initiated out of the 50 pledged by UNDP.

In areas where ClimSAT has been implemented, there is evidence that the output delivered to communities and policy makers and the information derived on the risks have been useful, and that stakeholders in participating Southern countries have been well-engaged in the process. For example, in the development of Uruguay's *Metropolitan Area Integrated Territorial Climate Plan*, specific information from ClimSAT on watershed and coastal erosion management, agriculture and food security was used.

However, Northern partners have in some cases not actually been as engaged as intended. The link between climate change mitigation and adaptation was not made in any of the projects. Funding was always a major challenge.

Without access to ClimSAT-gathered data, technology and training, participating regions would have struggled to understand or respond so well to the climate impacts they face. ClimSAT helped overcome this by using localised satellite imagery and localised climatological, socio-economic and opinion-based data to deliver extremely specific information. It then offered this information to those that need it most, not just those that could afford it. In this respect, it was a ground-breaking and extremely valuable resource.

Enablers/Critical Success Factors

Bespoke models and analysis. The key enabling factor of ClimSAT was the intricate detail to which scenarios and models were run on a case-by-case basis. As an ICT tool, ClimSAT offered for the first time indicative information on the major climate risks for some of the world's most vulnerable areas and communities. Offering information in an easy to understand, non-scientific format meant that technical information vital for creating better, more considered development plans was being accessed by relevant stakeholders. According to ClimSAT's Director, for example, participants in Montevideo praised the quality of the information delivered, and of the planning that ensued.

Figure 3: Officials from Uruguay Visiting ClimSAT Hub

Inclusive process. The theoretical and practical training given through ClimSAT has been cited as one of the successes of the programme (see Figure 3). As an inclusive and participatory programme, the recipient stakeholders remained relatively close to the technicians operating the systems throughout the programme, from the outset of feeding information into the models, through to delivery of recommendations. This inclusive set up and the sharing of critical information promoted ownership of the findings and empowered decision makers to act on the outcomes.

In-kind expertise and transferable knowledge. The support seen from the global scientific community in offering up expertise and access to technology and resources, often in kind, has been an enabling factor. Moreover, the sharing of findings and models between regions has potential to continue to deliver success from the initiative. While the specific impacts will remain relevant only to particular locations, the lessons learned in running project data through ClimSAT can be shared and improved with each particular project.

Constraints/Challenges

International climate change regime. In St Malo and during the run up to the Copenhagen COP15 summit in 2009, there was much hope for an international response to climate change. The failure of the negotiations dealt a major blow to ClimSAT and weakened the willingness to act of sub-national governments. Northern regions became less likely to enlist in ClimSAT.

Ownership model. Reluctance of Northern regions to politically or financially engage in ClimSAT has derived from the fact that it is seen as Brittany's, or as a French initiative. Moreover, there were significant cultural and operational differences between the bureaucracies of the UN and the partner regional governments which were challenging to work with. The UNDP's role has also been criticised, with commitments made not being delivered through its reluctance to continue to fund the project.

Economic crisis. In the time of austerity brought about by the global economic crisis, projects such as ClimSAT have struggled for investment. Northern regions do not demonstrate the same level of enthusiasm for North-South collaboration when they are forced to make operational cuts themselves – even those involved struggled to maintain their commitments. So resource scarcity across the economy made it difficult for ClimSAT to operate at the scale originally intended. Regions in developing countries therefore remained underinvested in, access to technologies was restricted, and progress was impeded.

Recommendations/Lessons Learned

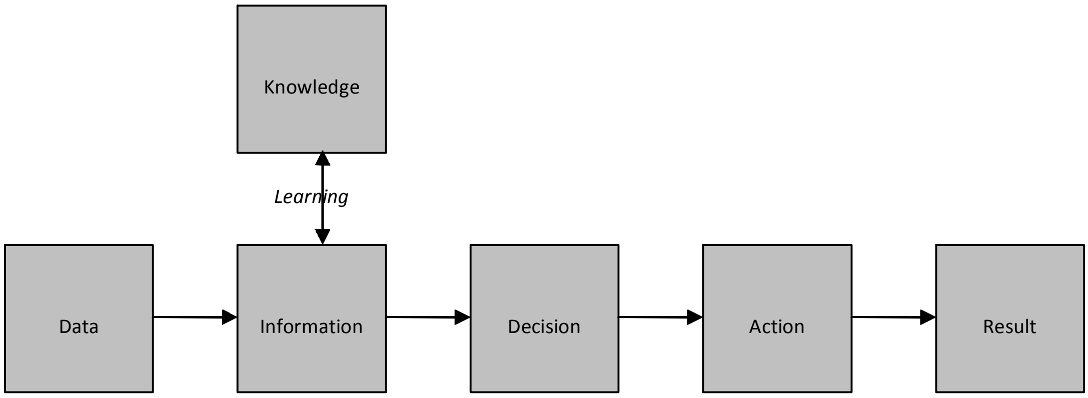

Figure 4: The Information Chain[1]

[1] Heeks, R.B. & Kanashiro, L.L. (2009) Remoteness, Exclusion and Telecentres in Mountain Regions: Analysing ICT-Based "Information Chains" in Pazos, Peru, IDPM Development Informatics Working Paper no.38, University of Manchester, UK http://www.sed.manchester.ac.uk/idpm/research/publications/wp/di/

Focus on data demand as much as on data supply, and on data use as much as on data production. Projects aiming to provide climate-related information for monitoring, modelling and related uses, should have a design that is rooted in the demand for data. In other words, they must start by asking not "What climate data can we create?" but by asking "What climate data is needed?" (or, more accurately, "What climate data is wanted?"). Without that, there will be uncertainty about the utility of the data outputs.

In a similar way, such projects need to pay significant attention to the access, uptake and utilisation of data by decision-makers and also to the enactment of those decisions, once taken. Put another way, they must attend to the entire "information chain" (see Figure 4) which ensures value from data by feeding decisions, actions and results from that data.

For the whole information chain to run effectively, projects must ensure knowledge is present to enable data to be accessed and understood; that motivations and power are present to enable decisions to be taken; and that other resources are in place to turn decisions into actions. There is evidence in the case of Montevideo that these resources were present but, without these, projects will achieve data production but not developmental results.

Make the link between mitigation and adaptation. While ClimSAT training included information on mitigation strategies, the projects undertaken have not mapped the critical linkages between climate adaptation and mitigation in practice. Efforts should be made to ensure that these elements are linked, and that it is not just adaptation that is the focus. This could potentially be done by altering how the real-time data is shared with developing country partners, so that potential ways of reducing or limiting greenhouse gases can be thought about earlier in the process. The central secretariat for programmes like ClimSAT also has a role to play in balancing data on both areas equally.

Recognise the value of neutral non-profit organisations. UN and government bureaucracies with competing priorities are not the optimal structure for a technology-based initiative like ClimSAT. An international NGO acting as a secretariat for the management of an initiative may encourage diverse Northern regions to enlist as partners. Such a non-profit structure could be seen as more transparent and accountable, and as a single-issue, neutral institution it could leverage more support – financial, political and societal – as a result.

Better promote ClimSAT findings. The findings and outcomes of the initial round of projects developing and utilising the ClimSAT tools have not been widely promoted, yet they are moderately positive. If there is no further UN resource available to staff or support ClimSAT, it is fundamentally important that the learning that has been delivered and the components of the technology that are open source remain accessible and readily available so that the legacy and successful outcomes of this phase of ClimSAT endure.

Use ClimSAT as a model for wider ICT-based climate change responses. ClimSAT has demonstrated that ICT has a role to play in helping society develop responses to climate change and this is a link that could be utilised much more. There is a need for more detailed, context-specific information – such as the data that ClimSAT was harvesting – which needs to be developed across contexts. ICT could potentially offer real-time monitoring of impacts to allow for more resilience, to prevent the worst consequences of climate change, or at least to plan better for them.

Data Sources & Further Information

The case study was developed by the author – Karen Anderton, Independent Environmental Consultant, karenlanderton@gmail.com – via correspondence with Alain Retiere, ClimSAT Director and Renaud Layadi, International Networks Project Manager, for the Regional Council of Brittany.

E3. Learning from Egypt's Environmental Monitoring and Reporting Systems

Author: Leila Hassanin

Initiative Overview

Egypt is facing increasing soil salinity and erosion of its agricultural lands in the Delta due to water level rises in the Mediterranean and decreasing flow of Nile waters. Coupled with meteorological changes impacting agriculture and rising demand for both water and food due to population growth, the country's climate change challenges are focused on adaptation in integrated coastal zone management, agriculture, and water resource management.

In its efforts to deal with climate change, Egypt ratified the United Nations Framework Convention on Climate Change (UNFCCC) in 1994, and was a signatory of the Kyoto Protocol in 1999, the latter having been ratified in 2005. Due to the Egyptian government's ratification of the UNFCCC it is obliged to provide periodic country reports that include data on climate, climate change and climate change effects, and also details of the adaptive and mitigative initiatives the country is implementing or is planning to implement. In order to produce such reports – and, more generally, in order to develop climate change policies and plans – a country needs an effective monitoring and reporting (M&R) system to gather all the different types of data from a wide variety of stakeholders.

What follows is therefore a case study of a developing country trying to set up its M&R system, particularly with a view to meeting its UNFCCC obligations. The Egyptian experience shows that it is relatively easy to set up the technical side of the system – the ICTs – but that this is not sufficient to ensure an efficient, integrated and sustainable tool for collecting, analysing and tracking climate change-related data and indicators that support decision making. The difficulties faced by Egypt in setting up its general climate change M&R system are contrasted with the relative success of two much more specific environmental information systems which have some climate change relevance: one monitoring water quality, one monitoring air quality.

Application Description

Egypt has a number of individual information systems of some relevance to climate change monitoring. Some – such as those of the National Authority for Remote Sensing and Space Sciences (see: http://www.narss.sci.eg/Projects.aspx) – directly relate to climate change. However, these are more for scientific purposes rather than national reporting. This study will therefore focus on the two M&R systems that have been used by major stakeholders and have contributed to decision making: the Marine Water Quality System and the Greater Cairo Air Quality Project. While not solely concerned with climate change – these are more general environmental monitoring systems – each does have some climate change relevance, and each can provide lessons for climate change information systems.

Egypt does not have a national, integrated climate change monitoring and reporting system. Even line ministries do not have M&R structures for climate change in their sectors. In the absence of a national climate change monitoring and reporting system, the UNDP Global Environment Facility has been facilitating the SMRES project: Strengthening the Monitoring and Reporting Systems of the MEAs (multilateral environmental agreements). Its goal has been to aggregate data across multiple sectors in Egypt to report to national decision makers and, internationally, to the Rio Conventions (http://www.cbd.int/rio/ - which include UNFCCC). But SMRES has been struggling to fulfil its mandate due to a number of obstacles that will be discussed further below, and contrasted with the experiences of the water and air systems. At the time of writing, SMRES appeared to be in abeyance, undergoing a period of re-assessment to improve its output.

In the three examples above – water quality, air quality, and SMRES – ICTs provide the technical underpinnings of the monitoring and reporting systems. ICTs are used in the scientific equipment that tests and analyse (e.g. air, water) samples, and then aggregates the data and passes it on to the central information system. That central system is ICT-based and stores, processes and communicates the environmental data. More specifically, geographic information systems (GIS) are used within the systems to display the data. (This case study focuses on monitoring and reporting, and therefore does not include other uses of ICT, including modelling of climate change, and disaster early warnings systems.)

Drivers and Purposes

The Egyptian Environmental Affairs Agency (EEAA) has identified five key areas of vulnerability in the country that are likely to be exacerbated by climate change: coastal zones, agriculture, water resources, human health, and coral reefs.

For example, Egypt is a country that has been, and is projected to be, highly vulnerable to rising sea water levels; those sea levels in turn occurring due to climate change (Agrawala *et al.* 2004); see also Figure 1. The Nile Delta already has a salt wedge reaching 30 kilometres inland and there is not enough water in the northern part of the Delta to wash out the sewage, fertilisers and industrial waste that accumulate in the soil. If the projections of the Intergovernmental Panel on Climate Change (IPCC) are right the Nile Delta will lose one third of its lands by 2050, resulting in massive displacement of people and loss of valuable agricultural land (Hassanin 2010). The government has been implementing adaptive measures and is monitoring changes in sea levels both on its northern borders with the Mediterranean and along the Red Sea.

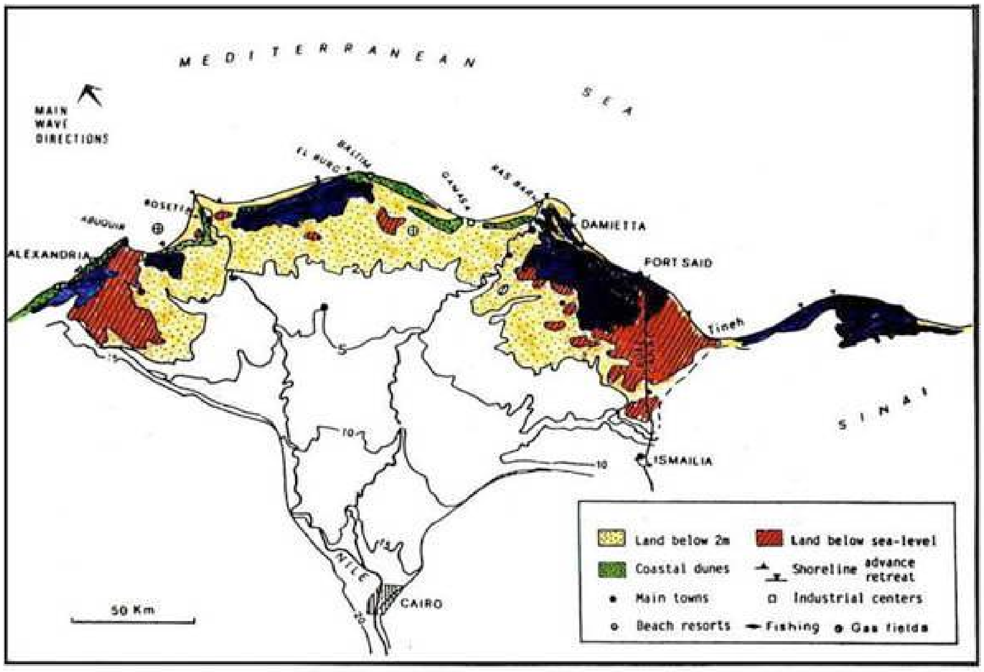

Figure 1: Nile Delta Topography Showing Areas in Danger due to Climate Change (source: El Raey 2007)

More generally, agricultural production and food supply are being threatened by climate change. There are also strong concerns about sustainability of fresh water supply. Many of the causes of water quality and availability problems are non-climate change related – e.g. the rising population, industrial output and agricultural run-off – but growing salinity and changes in rainfall patterns due to climate change are making matters worse. Likewise with air pollution, a major problem in Egypt's main urban areas. This has traditionally be handled separately from climate change, but the two are interconnected: air pollutants contribute significantly to climate change, and it is also possible that climate change may exacerbate some aspects of air pollution (SEI 2008).

In the face of these exacerbated vulnerabilities, the government needed to gather data on the current status of these issues, in order to make well-informed and effective decisions. It therefore facilitated the creation of the three monitoring and reporting systems identified earlier:

- The Marine Water Quality System which (see Figure 2) gathers data and reports on water quality in coastal areas, covering both quality of sea water (e.g. including pollution around coral reefs in the Red Sea) and also the impact of saline water on coastal agriculture.
- The Greater Cairo Air Quality Project which (see Figure 3) gathers data and reports on air quality in the Greater Cairo area, focusing on levels of lead, hydrocarbon particulates, NO_x gases, and black carbon among others.
- SMRES which aims to be cross-sectoral, and integrate various sources in order to support global reporting on climate change.

As noted above, all three of these systems are completely dependent on ICTs for all aspects of their functioning: data capture, storage, processing, and output.

Figure 2: Coastal Water Monitoring Stations (courtesy EEAA)

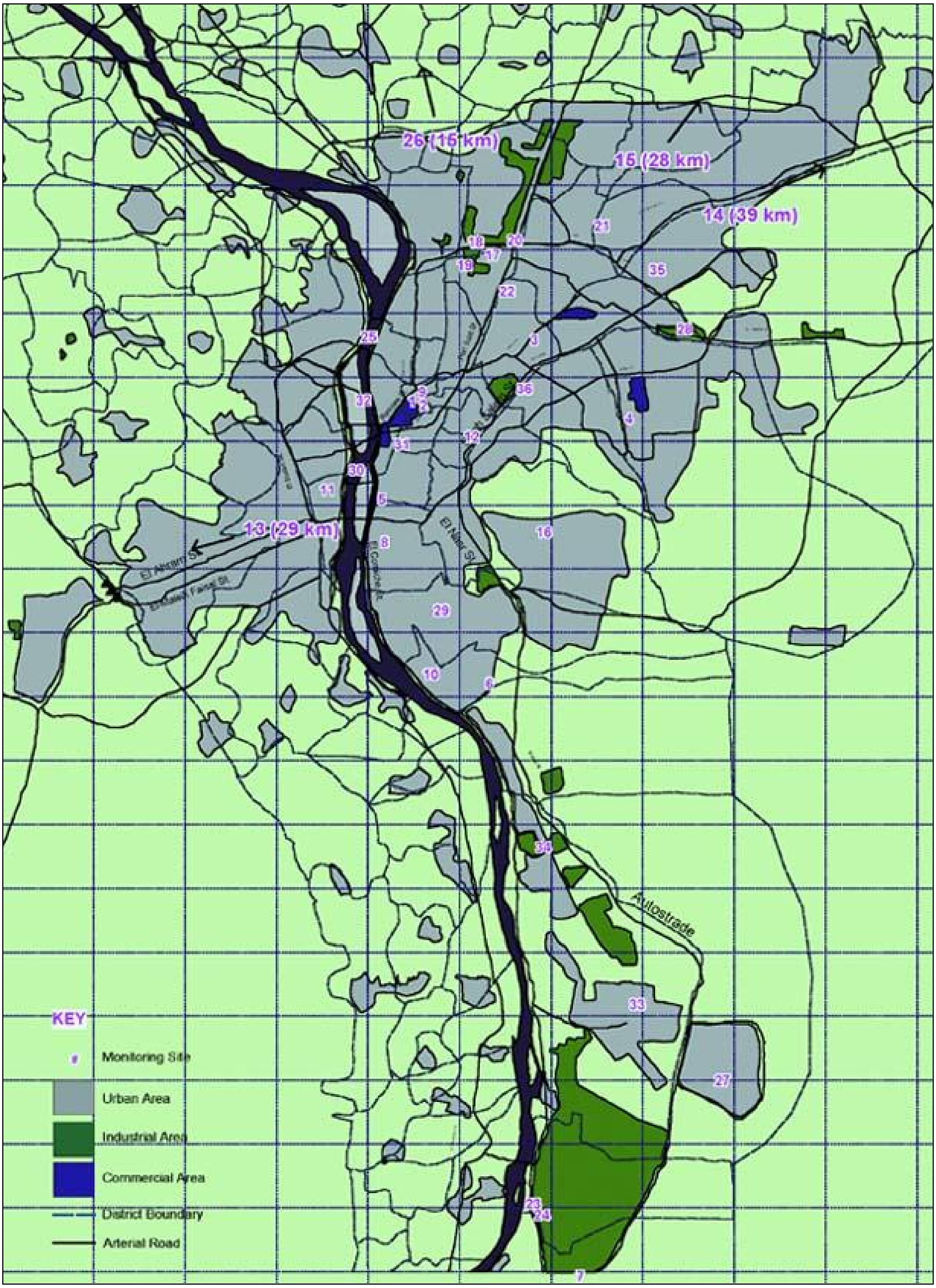

Figure 3: Cairo Air Monitoring Stations for the Greater Cairo Air Quality Project (courtesy EEAA)

Stakeholders

The air and water quality systems have specific, and relatively limited, stakeholders. The Marine Water Quality System is an EEAA project in collaboration with the coastal governorates (Egypt's equivalent of states or provinces) and water-related research bodies. The Greater Cairo Air Quality Project is a more multilateral initiative including USAID and its contractor (Chemonics), the Ministry of Health, World Health Organisation, EEAA, and local authorities and organisations within the Cairo area.

SMRES – and climate change monitoring more generally – has an even wider remit and wider set of stakeholders (see Figure 4). Egypt does not have specific climate change policies or legislation. However – through the Environmental Protection Law (4/1994) and its amendment (9/2009) – the Ministry of State for Environmental Affairs (MSEA) and the Egyptian Environmental Affairs Agency are responsible for all environmental laws and policies and are the country's focal point for environmental monitoring and reporting. Their remit therefore covers climate change, and they can be seen as the nodal agencies for this application.

Line ministries like the Ministry of Agriculture and Land Reclamation, Ministry of Water Resources and Irrigation, Ministry of Health, Ministry of Transportation, the National Agency of Energy and local authorities like the governorates would be important generators of climate change data for central aggregation by the climate change unit (CCU) within the environmental agency. But they would also be important users of that data as well. In addition, various university departments have been co-opted to provide data inputs.

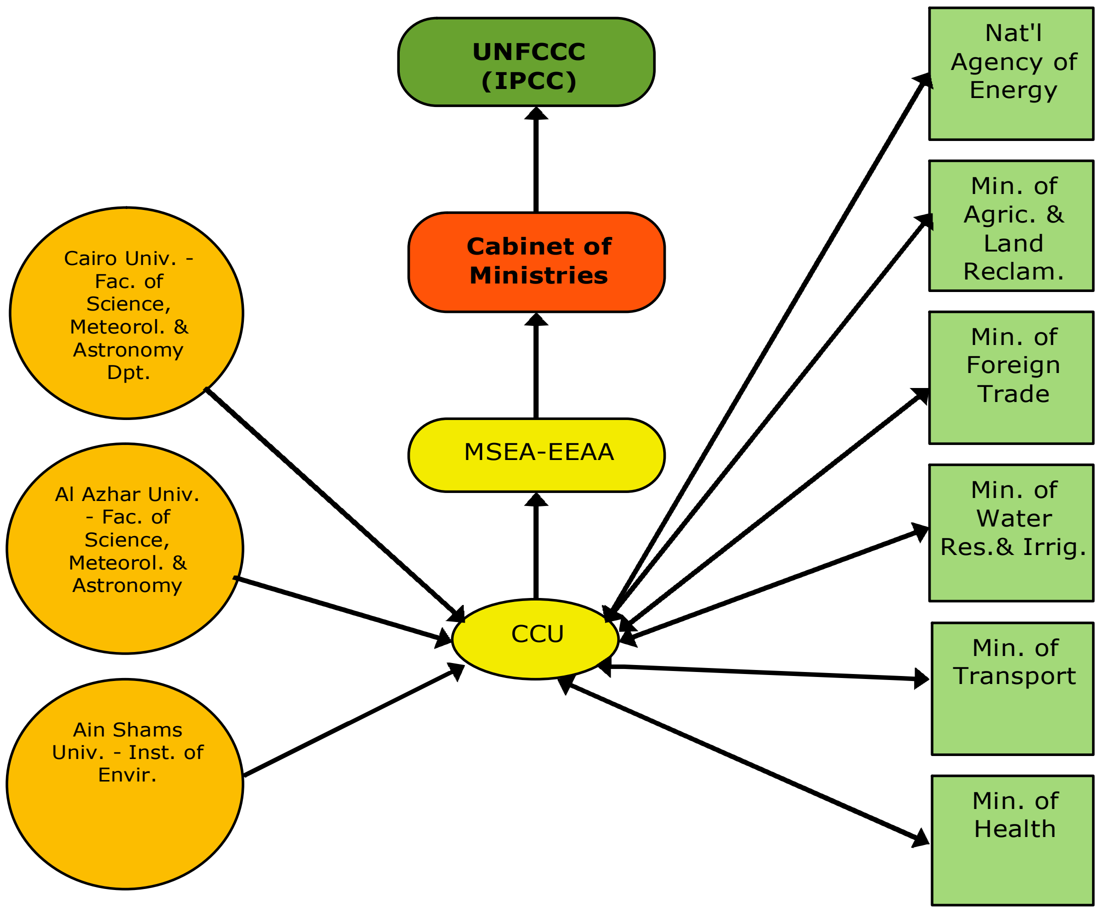

Figure 4: Stakeholders and Data Flows for National Climate Change Monitoring and Reporting System

Beyond the specifics of SMRES – and in order to implement its UNFCCC obligations – Egypt established a National Committee on Climate Change in 1997, developed a Climate Change National Strategy and Action Plan, among other initiatives; and built capacity that translated into the Initial National Communication (EEAA 1999) and the Second National Communication (EEAA 2010a) sent to UNFCCC.

Impact and Evaluation

The financial and in-kind costs of the systems described here often involve several parties with differing contributions. The Greater Cairo Air Quality project, for example, was partly funded by USAID and managed by an American contractor, Chemonics. The Ministry of Health was for a while an independent contributor, responsible for monitoring sulphur dioxide, total suspended particulate matter, and smoke. WHO contributed by helping to set monitoring standards (Nasralla 2001). Since the early 2000s, EEAA has added its own air monitoring programme to the project, measuring small (PM10) particulates, carbon monoxide, nitrogen dioxide and ozone. EEAA is also involved through another separate programme that temporarily measured lead levels.

Combining different stakeholders and thus collectively using their resources such as monitoring equipment, ICT systems, laboratories, staff, etc, helps to save overall costs. However, overall, very large amounts have been invested. USAID has invested up to US$50 million per year in the project to improve air quality in Cairo. The total amount invested in the five-year, Danida-supported programme to improve monitoring of coastal water and air quality was US$17 million. The costs for a planned virtual network centre for climate research are around US$50 million (EEAA 2010b). It is not possible to distinguish within these overall budgets what the exact figure is for the ICT component.

In assessing what has been achieved from these investments, one can distinguish between the relative success of the narrowly-focused water and air quality systems, and the relative failure of the broader climate change M&R system. The former two have been able to create a means by which data is gathered on a regular basis – twice monthly for water quality, monthly for air quality. This has relied on work done to standardise data inputs from different sources, enabling it to be aggregated.

This initially proved difficult for the air quality project: its sub-components had different objectives, different data profiles, poor quality equipment, and different types of equipment (Nasralla 2001). But this was then addressed through additional USAID funding which paid for staff capacity building, new equipment, and a unification of data collection, data handling, and data analysis procedures among stakeholders.

Both the air and water information systems therefore work effectively as monitoring and reporting systems. They have also had some successes in seeing the information they produce turned into decisions and actions. For example, the number of air pollution episodes in Cairo fell from 31 to 4, lead levels have been reduced, and buses converted to natural gas (Chemonics 2004).

By contrast, inter-sectoral initiatives for climate change monitoring and reporting, like SMRES, have been much more problematic. Even the foundations of standardising the data that is to be used, aggregating that data, and managing it, have proven very hard to achieve (interview data from EEAA project manager). The current suspended state of the SMRES project is one clear example. The central unit within EEAA has not been able to obtain the necessary data from stakeholders as per the intentions shown in Figure 4: they have treated the data as personal property that is not to be divulged or shared. The data that has been released uses different and incommensurate forms and indicators. So, while the ICT technical base for the system has been put in place, it is not functioning as intended. Lacking core funding from EEAA, the system has proven unsustainable.

Enablers/Critical Success Factors

Comparing the success and failure differentials, the following enablers can be identified:

Where stakeholders share **common objectives**, then monitoring systems seem to have performed relatively well. For example, with the water quality system, the coastal governorates want to address water quality issues – they lose tourist and agricultural revenue if there are problems with water quality and problems with salinity, and have to deal with health problems. Their interests and objectives therefore align well with those of the Environmental Information and Monitoring Programme within EEAA that has overall responsibility for coastal water monitoring. It has helped that EEAA has branch offices in each governorate, which can assist with data collection and with local discussions. It has also helped that donor funding could be used as a "carrot" to encourage cooperation and to ensure delivery of a working M&R system.

Adequate initial and recurrent financing. Donors like Danida and USAID have provided the significant sums necessary to get the air and water monitoring systems up and running. The recurrent operational costs for the systems have been lower, and the EEAA has to some degree been able to sustain these from its core budget.

Focused staff capacity development. Although knowledge and skills were lacking initially for the air and water systems, it was relatively easy for donor funds to help create the absent capacity. There was a clear and relatively narrow expertise-set required – for example linked to particular hardware, software or data techniques – which intensive training was able to address on a fairly short time-scale. (By contrast, SMRES' many stakeholders and broad remit have made capacity building much more difficult.)

Being results-led not technology-led. The focus for the water and, especially, the air quality monitoring systems has been the results that were to be achieved: cleaning up Cairo's terrible pollution in the case of the latter. ICTs were therefore relegated to their proper place: as tools to be used to achieve those results, rather than being placed centre-stage. (With more complex integrated climate change projects like SMRES, so much needs to be done that the focus can fall back to being the ICT platform, with the result that the technology is put in place, but without the means or planning to work out how to use it. The ICT can therefore become the end not the means for the project.)

Constraints/Challenges

Absence of carrots and sticks. If an individual organisation receives funding to pay for resources for its own purposes, it has a direct motivation to participate. But inter-sectoral climate change systems often pay significant sums for resources that sit between, rather than within, organisations; and that – more importantly – support activities those organisations regard as peripheral. Such initiatives will struggle to succeed. All the more so if the lack of carrot is matched by a lack of stick. In the case of EEAA, it is relying on much more powerful line ministries to "make nice" and cooperate. EEAA does not have the political clout or the enforcement capacity to obtain compliance from those ministries.

Proprietary data motivations. Line ministries and local authorities tend to regard the data gathered from their sector or geographic region as their sovereign property, which they are not eager to share with others. In some ways this is a basic issue of motivation: the problem with carrots and sticks was just noted, and sharing data also tends to be an additional workload placed onto individual officers with no assistance or incentive provided for them. It is often cited as a cultural matter: in many developing countries, there is a culture of secrecy and an absence of transparency norms. But this, also, may in part relate to motivations (interview with EEAA project manager). If stakeholders are not sure how the data they provide is going to be used or, worse, if they fear it may be used in some way adverse to their interests – for example to criticise them for failing to reach targets, or by having funds diverted to other purposes – then it is not surprising that they are reluctant to share. Such perceptions may, of course, have no basis in reality but merely arise from unsubstantiated fears.

Inadequate stakeholder participation. Motivation also partly derives from feelings of ownership and involvement. The failure of SMRES to get the participation of stakeholders from early in the design phase, meant a failure to develop those positive feelings. It thus felt like a system imposed from outside, rather than something in which those organisations did, indeed, perceive they had a stake.

Unsustainable funding. Many climate change information systems are developed through project-based donor funding. The problem with such funding is that projects have a definite end point. Unless government organisations have the means to cover the recurrent financing from within their core budget – particularly to cover staff costs and costs of ICT maintenance and upgrade – the systems will be at risk. This becomes even more challenging where the system relies on many different government agencies, each of which needs to provide core budget support.

Absence of hybrid perspectives and capacities. Effective implementation of climate change information systems requires a "hybrid" perspective that combines both the technical and the organisational. It requires socio-technical expertise that understands data, technology, people and context. But this has sometimes been missing. For example, with SMRES, the Ministry of Communication and Information Technology (MCIT) was commissioned to set up the climate change and other environmental databases that the system would require. But MCIT sees itself purely as a technical provider, rather than taking a hybrid perspective that would involve it in thinking about how to ensure data flows, or how to develop the institutional capacity to make the databases useful. As a result, once it has laid the hardware, software and telecommunications infrastructure, MCIT regards its role as completed because the technology works even though the monitoring system it is supposed to support, does not.

Recommendations/Lessons Learned

The main lesson coming out of the Egyptian experience in setting up various national and subnational climate change-related monitoring and reporting systems is that stakeholders should **put human and organisational design ahead of ICT design**: they should refrain from setting up the ICT platform before having worked out the more complex institutional, financial and scientific technicalities of their initiative. Taking SMRES as an example, it would have made more sense to secure a sustainable funding source at the design stage, to have stakeholders work together to set the system up, and to have a clear understanding of why certain data are collected and how they will be used. If training and equipment needs would have been assessed from the start and indicators and methodological standardisation agreed upon in the design and planning stages, that also would have helped.

For decision makers it is tempting to first build the ICT platform as it is quick and relatively straightforward to set up, and it provides a tangible deliverable. But climate change monitoring and reporting is in many instances reflective of the **political will** towards climate change. Often the ratification of a Convention leads directly to production of a shopping list for funds and loans, rather than being reflective of a serious interest in climate change. As long as this game is convenient to both the developed and the developing nations it is questionable that one can stop this scenario from repeatedly happening. As long as stakeholders lack the incentive to produce reliable data for the benefit of a common goal then weak, failing and fragmented climate change monitoring and reporting systems are the natural outcome.

In addition:

Aim low and hit, rather than aiming high and missing or **"KISS: keep it simple, straightforward"**. A central difference between the systems that have worked relatively well, and the system that did not is scope and complexity. Successful climate change information systems are those that keep the technology fairly simple, have quite focused objectives, require more limited funding and involve relatively few stakeholders. Rather than aiming for the best possible ICT systems, it is better to form a realistic assessment of what can actually be achieved given the allocated funds and timescale, and to keep things simpler rather than not.

Have an answer for the "golden question". The golden question – the one that everybody involved with a climate change information system asks – is "what's in it for me?". SMRES has had problems largely because it has been unable to provide a convincing answer to that question for most of the stakeholders. Successful projects address this motivational issue. They may provide financial carrots or regulatory sticks. And they provide reassurance about how data is going to be used; ensuring that those who share their data will not be disadvantaged by so doing.

Data Sources & Further Information

The research is based on first- and second-hand data derived from personal experience and from interviews, observation, document analysis and knowledge mining. The author – Leila Hassanin, Independent Environmental Consultant, lhassanin@gmail.com – has been involved in environmental monitoring and reporting systems, and in ICT and environmental sustainability research in Egypt and internationally. Her interest in climate change M&R systems grew out of first-hand experience with the need for data quality and consistency for implementation, based partly on her association with EEAA since the mid-1990s.

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Part F: Case Studies of *ICTs and Climate Change Strategy*

F1. Using ICTs to Integrate Frontline Views into Strategic Planning for Climate Change

Authors: Terry Gibson and Nigel Scott

Initiative Overview

The Intergovernmental Panel on Climate Change predicts increasingly intense weather conditions as a result of climate change, which will increase the threat of climatological and related complex disasters (UNISDR 2008). Data from the Centre for Research on the Epidemiology of Disasters (2008) indicates that in 2007, for example, floods and windstorms accounted for 86% of the overall disaster mortality, and hydro-meteorological disasters accounted for more than 98% of the total affected by disasters. Coherent strategies and effective implementation of measures to reduce the vulnerability of people are critical as climate change escalates these hazards in frequency and intensity.

The Hyogo Framework for Action 2005-2015 (HFA) is one such initiative, adopted by 168 countries at the World Conference on Disaster Reduction in Japan in 2005. It promotes a strategic approach to reducing vulnerabilities to and risks of hazards, with the ultimate goal of reducing disaster losses by 2015. The United Nations Global Assessment Report on Disaster Risk Reduction presents an analysis of disaster risks including an overview of progress towards the Hyogo Framework for Action based on self-assessment of progress by over 130 governments (e.g. UNISDR 2011). 'Views from the Frontline' (VFL) fills a gap in the monitoring process by providing a complementary view of progress based not on government self-assessment, but on the experience and views of people living in disaster-prone communities – those on the 'frontline'.

'Views from the Frontline' is a process of gathering information on disaster risk reduction at a local level. Local organisations gather both qualitative case studies and quantitative data from face to face surveys – low cost digital video technology is used to create annotated case study videos, and email and spreadsheets are used to coordinate and manage survey data. In 2011, VFL also trialled an experimental programme to research the use of SMS surveys using mobile phones.

The first VFL report was published in 2009, and a second report (GNDR 2011) was presented at the UN Global Platform for Disaster Risk Reduction in 2011. VFL is seen to provide a generic model by which the voices of local communities can be heard in the debate on climate change and on wider resilience by those in strategic decision-making positions.

Application Description

VFL aims to inform policy making processes such as the Global Platform for Disaster Risk Reduction by providing evidence of what is happening on the ground. For VFL 2011, a short questionnaire was designed comprising 20 questions on local government issues, plus 5 questions about the respondent (e.g. age, gender, location), and 2 questions to establish views on the threat of disaster and progress in reducing disaster losses. Questions on local government covered inclusion and participation, policies and capacity, and accountability and transparency; for example:

- Does the local government ensure women and men participate equally in disaster prevention decision-making and implementation?
- Do local government officials have clear roles and responsibilities to carry out disaster prevention?
- Does the local government regularly monitor and report on progress on disaster prevention?

The case studies ('Actions at the Frontline': see GNDR 2011a) serve to illustrate findings from the survey data, and provide a deeper understanding of how progress is being supported or challenged.

Face to face interviews and group discussions with key informants were carried out by Participating Organisations (POs). POs are typically local civil society organisations, which are supported by a National Coordinating Organisation (NCO). A data entry tool (running on Excel) was provided to enable NCOs to input the data into a structured database for analysis (see Figure 1).

Figure 1: Example of Excel-Based Data Entry Screen for Returning Survey Results

While the VFL process is essentially one of communication upwards through a network, it has been eased by access to simple ICT infrastructure. Email was used to send questionnaires to POs throughout the network, to return data sets to the secretariat, and to disseminate findings and reports to network members. Although Web 2.0 technology has been used to enable members to take part in blogs, online discussions, and a session at the Global Platform event in 2011 was streamed through the GNDR website, members make greater use of simple email discussion lists. The use of ICTs in the VFL process is highlighted in Figure 2.

As part of the 2011 VFL process, GNDR worked with the telecommunications company Txteagle (renamed Jana in late 2011) on an experimental programme to research the use of mobile phone technology for surveys. Txteagle have developed a compensation platform that has been integrated with billing systems of 220 mobile operators around the world, giving them access to 2.1 billion phone numbers in 80 countries (MobileActive 2011). Txteagle uses various mechanisms to recruit phone subscribers as 'members', who opt in to the process - Txteagle then invite members to complete surveys in exchange for airtime. Invitations to take part in the VFL 'eSurvey' were initially sent via SMS to Txteagle members in 36 countries (see Figure 3). Respondents could choose to complete the survey using a webpage, or through a multiple exchange of SMS messages.

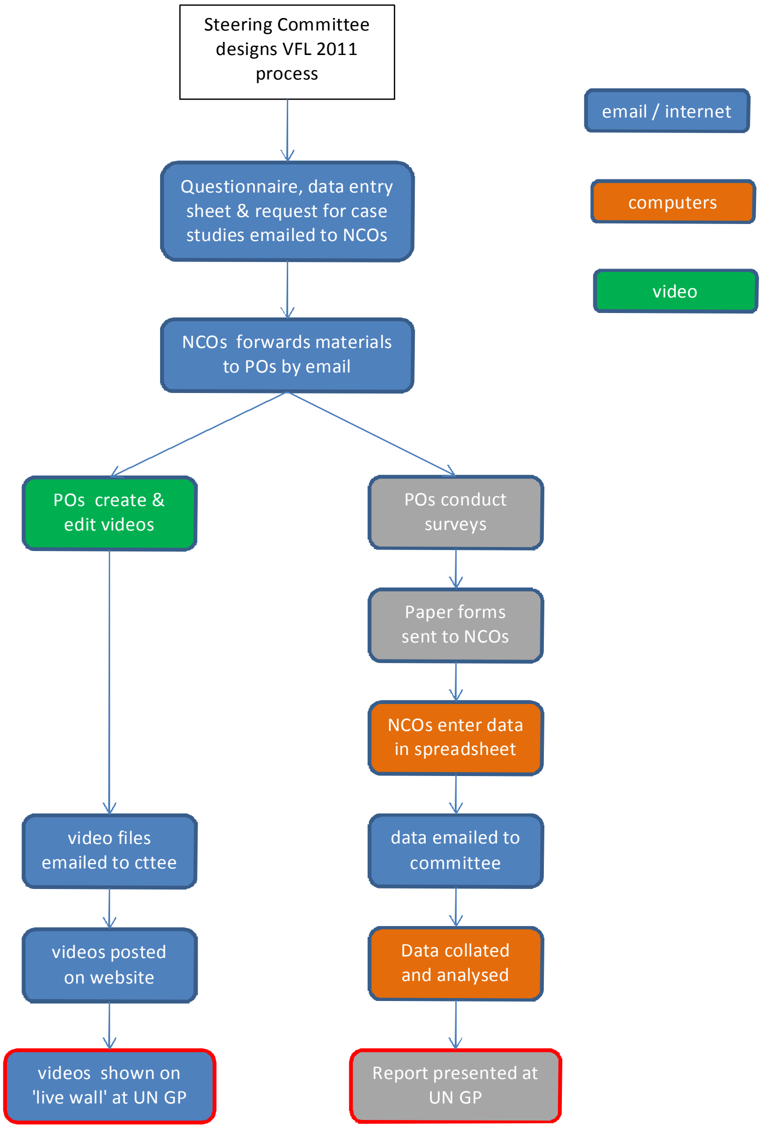

Figure 2: Schematic of VFL Process

Figure 3: Invitation Message to Participate in eSurvey by Phone

Formal Drivers

The main goal of 'Views from the Frontline' is to support the effective implementation of the Hyogo Framework for Action to build the resilience of vulnerable people and communities at risk to disasters. The HFA is structured around five 'Priorities for Action' which identify steps which can be taken to reduce the vulnerability of urban and rural populations to natural disasters, 75% of which are climate related (Holmes 2009). Its particular contribution is to provide a complementary local level assessment of progress which indicates whether policy development based on the HFA Priorities for Action is being translated into effective implementation of that policy at local level.

Objectives/Purpose for ICT Usage

Video was used for case studies because visual images in a two-minute package are a particularly effective means of communicating to policy makers, both at a national and international level. The reach and quality of internet connectivity in developing countries has now reached the point where network members can effectively use email for coordination and sharing data files.

Paper based surveys using face to face interviews are labour intensive and costly. The eSurvey approach was proposed as a cost effective means of extending the reach of the survey beyond the local networks of POs.

Stakeholders

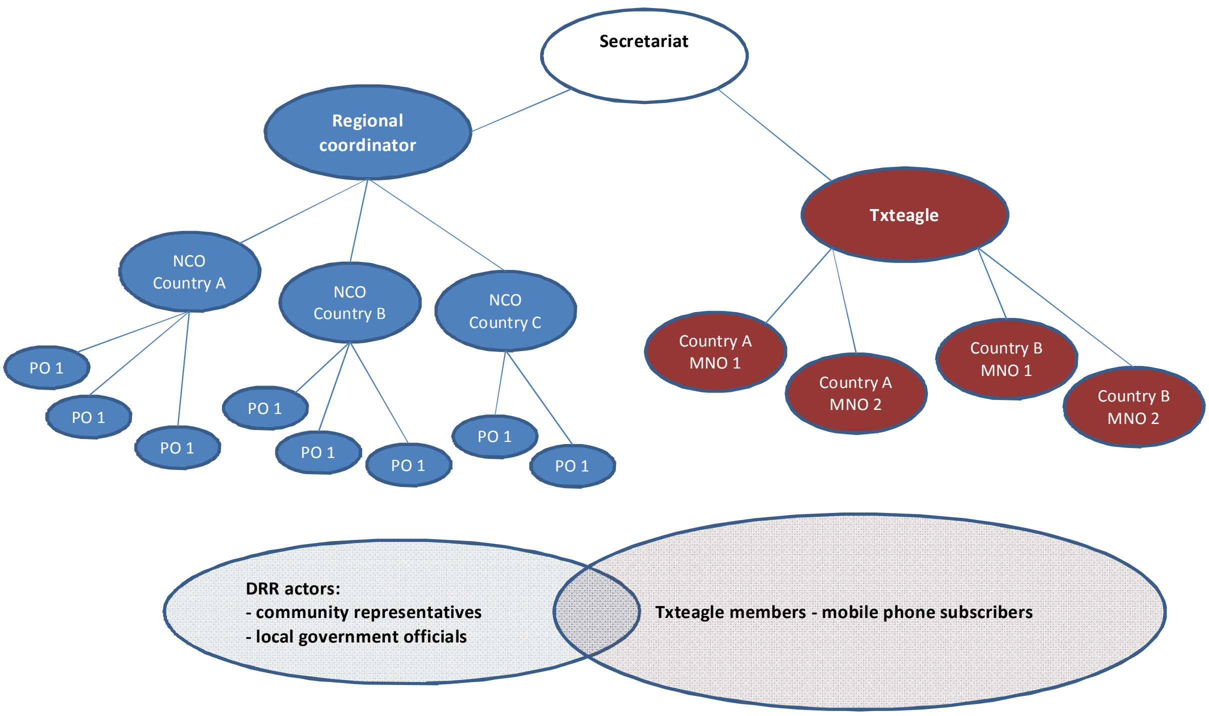

Figure 4: Overview of VFL Stakeholders in VFL Data Gathering Activities

The implementation of Views from the Frontline was undertaken by various network members (see Figure 4):

- Participating Organisations. Typically between 6-12 local civil society organisations that were responsible for conducting interviews and focus group discussions with key informant groups, and for gathering case studies.
- National Coordinating Organisations. In each country an NGO taking this role established a national team of POs, provided training, and coordinated the surveys and case studies.
- Regional coordinator. In each of the eleven regions[1], a national NGO took responsibility for coordinating the work across different countries.
- Secretariat. A small group was responsible for overall management and for international level advocacy, supported particularly by GNDR, the Global Network for Disaster Reduction. This was supported by a professional and academic advisory group.

Txteagle were contracted as a mobile telecommunications specialist to coordinate the eSurvey, based on both mobile phone and internet technologies and acting through various individual mobile network operators (MNOs).

Impact: Cost and Benefits

In the VFL 2009 study, over 400 civil society organisations were mobilised to conduct over 7,000 interviews across 48 countries. The endeavour was ultimately successful, as it achieved the objective of influencing the UN system:

> *'Views from the Frontline shifted the agenda at GP-DRR 2009 towards a focus on execution of the Hyogo Framework at the local level'.*
> Margareta Wahlstrom: Assistant Secretary General for Disaster Reduction to the UN (presentation to GNDR workshop January 2010)

The impact at the international level was complemented by impact at the national and local level. This was documented in a learning review based on surveying 49 of the participating organisations (GNDR 2010). Many respondents reported opportunities to establish new platforms and partnerships which were able to promote the translation of national policy on reducing risk from climate change-related disasters into practical implementation. In Afghanistan, for example, the Participating Organisation reported that the survey had been a major stimulus in the establishment of a national multi-stakeholder platform and the implementation of a strategic action plan for risk reduction.

Two years later, VFL 2011 extended the reach of the survey to over 20,000 interviews conducted by over 500 organisations in 69 countries. This success reflects the value that POs themselves attribute to this kind of information in their own advocacy work. A key conclusion of the 2011 survey was that 57% of all respondents believed that disaster losses were increasing, rather than decreasing. This fact reflects the trends reported by CRED (2008) demonstrating increasing climate change-related disasters. This statistic is important as the stated aim of the UN ten-year programme (of which more than half had elapsed at the time of writing) is a significant *reduction* in disaster losses. This statistic was therefore used as a central campaigning and advocacy message.

VFL is part of a dynamic cycle of activities that interact with both UN and local processes. Although it will take time for specific impacts of VFL 2011 to become evident, the network is reflecting on the effectiveness of the UN process to influence its membership to take positive actions towards achieving the goal of building the resilience of vulnerable communities.

Participating Organisations estimate that the total cost of face to face surveys works out at about US$125/respondent, which includes training, mobilising communities, transport and logistics. However, the actual cost to GNDR is much less, at US$53/respondent. This is because POs made significant contributions in kind, mostly by using their own staff; some also gathered much larger sample sizes where they had a particular interest in the data.

[1] Central America, Central Asia and Eastern Europe, Eastern Africa, Middle East and North Africa, Pacific, South America, South Asia, South-East Asia, Southern Africa, Southern Caucasus, and Western Africa.

The mobile phone based eSurvey (see Figure 5) has the potential to lower the cost of conducting a simple survey by an order of magnitude – the cost to GNDR of gathering over 36,000 surveys worked out at just under US$5/respondent. In 2011, the total cost of the survey was therefore just under US$1.3million – around US$1.1million for the c.20,000 face-to-face respondents; around US$200,000 for the 36,000 eSurveyed respondents.

Figure 5: Community Representative Participating in eSurvey, Bangladesh

Evaluation: Failure or Success

The VFL process has been a success. It has proved successful in changing policy at both the international level (see quote above), and the local level e.g. the national platform and strategic plan for Afghanistan mentioned above.

The eSurvey was a partial success. The pilot demonstrated that the technology works – mobile phone subscribers will complete a short survey. The survey was conducted in two main phases. In the first phase, Txteagle members were sent an SMS message inviting them to take part in the survey, and were given a choice of completing the survey through an exchange of SMS messages or using Txteagle's web interface.

A further pilot phase (outlined below) explored an experimental protocol which was intended to overcome limitations evident from the first phase survey. It was clear that the 'reach' of the eSurvey into low income subscribers was constrained by issues linked to airtime credit – people with no or low credit were not able to complete the survey because remuneration was awarded only on completion of the survey, and people opting to use the internet interface tended to be from higher status socio-economic groups.

It was interesting to find that almost all respondents in the first phase of the pilot chose, after the initial text invitation, to complete the survey using the web interface. Results were similar to those of the face to face survey. Although the eSurvey proved a cost-effective way of extending the reach of the VFL process, the methodology does not appear to have reached into vulnerable communities. Respondents to the eSurvey feel they are at lower levels of risk of disasters than face to face interviewees, confirming they are less likely to be drawn from vulnerable communities. It was proposed that low status respondents to the eSurvey might be representative of vulnerable communities, but the data does not support this.

Designing the eSurvey approach stimulated more critical thinking on the sampling methodology for VFL. By targeting key referents, the face to face process generates informed views from at-risk communities. By sending invitations to a pool of mobile phone subscribers, the eSurvey offers the potential to generate information that is representative of a given demographic. The network needs to reflect on a methodology that will be most helpful in influencing change at a local level.

Enablers/Critical Success Factors

Partners and direct interaction. VFL is more than a data gathering process. When a Participating Organisation moves into an area to conduct interviews, it engages with authorities and civil society organisations in order to secure permissions and cooperation. This has turned out to be a key activity in stimulating dialogue and mobilising communities to push for change at a local level. However, when a person completes an eSurvey questionnaire, he or she does so in isolation, so there is no opportunity to generate any sense of shared or PO identity among people with a mutual interest in disaster risk reduction. A local partner can act as a focal point for information, contacts or even leadership, playing a catalytic role in converting awareness into action.

Internet access. In the first part of the eSurvey, Txteagle generated nearly 28,000 responses from 36 developing countries. The interesting feature was that over 99% were submitted via the webpage – only in Kenya did people submit responses using SMS. The level of access to the internet, even extending to rural respondents, was a surprise, and an indicator that the internet may be more-widely usable as a data and interaction channel for climate change strategy than had previously been thought.

Constraints/Challenges

Reach. The first phase of the eSurvey tended to reach young, urban males. This simply reflects patterns of mobile phone ownership (subscriber rates among women in low and middle income countries are 79% of subscriber rates among men (GSMA 2010)) and internet access (in Africa, twice as many men use the internet as women (Gillwald et al. 2010)). Literacy, poverty and ICT literacy are additional barriers that further impede the participation of women and rural residents. The personal interaction of enumerators in face to face interviews plays an important role in overcoming barriers of literacy and gender discrimination.

Sampling. The eSurvey exercise highlighted a number of issues associated with the self-selection of respondents:

- At an international level, there were huge variations in the sample sizes obtained from different countries, highlighting a lack of control over sampling;
- Gender discrimination present in a country was manifest in samples from both face to face and eSurveys;
- NCOs can target communities according to their assessment of vulnerability, whereas mobile phone surveys are more likely to reflect patterns of mobile coverage.

Airtime credit. *"In Kenya, approximately 40% of mobile users don't keep a balance on their mobile phone."* (Hersman 2010). Found in many developing countries, this lack of credit makes it impossible for many people to participate in an SMS survey that reimburses them for airtime after (or during) the survey (as was the case in this survey) - they cannot even send an SMS to register their interest or accept the invitation. It also helps explain why the eSurvey was not so effective at reaching the more marginalised sectors of society (e.g. rural women) who are more likely to be among those users with no airtime credit on their phone. The invitation message from the eSurvey advised users *"You will be compensated in airtime for its completion"*, but it was clear that this caused difficulties:

- People did not have enough credit on their phones to send the full complement of 29 SMSs;
- People did not understand that they needed to complete all 29 questions before receiving compensation;
- The vast majority of respondents used the web interface, which required a much lower 'investment'.

Only in Kenya were Txteagle able to persuade the operator to credit phones with very small amounts, equivalent to the cost of a single SMS, which enabled them to compensate users on a question by question basis. The fact that Kenya was the only country where respondents submitted data using SMS highlights the importance of airtime credit issues.

UCMP-Based Second Phase eSurvey. Txteagle tried another way of overcoming the airtime credit barrier - sending questions to handsets using UCMP (see Figure 6). UCMP (Universal Cellular Messaging Protocol) is an experimental protocol using the GMS control channel, which is currently being developed by Txteagle. It initiates a 'session' by sending an invitation message to a mobile phone; if the respondent accepts then messages are exchanged over the duration of the session, typically 10 minutes.

Figure 6: Respondent Testing UCMP Pilot in Bangladesh

The main advantage of a UCMP survey is that there was no cost to the user. The cost to GNDR of administering the survey using UCMP was similar to the cost of the SMS survey. This approach was tested with collaborators in Bangladesh during a field visit by GNDR staff. The test showed that in principle the protocol was effective. The field observations highlighted limitations due to the protocol being 'session based' so that if people switched to another task or decided to respond later then they dropped out of the survey. Additional instructions and a simple routine for re-entering it were added in this version.

A sample of nearly 9,000 responses generated from 49 countries showed mixed results (see Table 1). For example, UCMP samples from countries in Asia were even more strongly male biased than the mobile / web samples, but in Latin American countries the gender balance was actually reversed, making the samples female biased. In all countries, the UCMP samples achieved a reasonable rural / urban balance, unlike the mobile / web samples which tended to have a strong urban bias. In most countries the UCMP sample was younger than the mobile / web sample.

	Mobile / web	UCMP
Male : female	74 : 26	72 : 28
Rural : urban	20 :80	57 : 43
Proportion of under 18s (%)	12.5	20.5

Table 1 : Comparison of Demographic Indicators between Mobile / Web and UCMP Samples (Entire Samples)

There is no consistency in the data on changes in disaster losses or on perceived threats of disasters, so it is not possible to say whether the apparent improved reach of the UCMP survey (in terms of demographics) has actually resulted in an improved reach into vulnerable communities.

Recommendations/Lessons Learned

Mass local surveys provide an effective input to climate change strategy. The VFL experience has demonstrated that it is quite possible to add mass survey-based evidence to climate change-related strategic processes; thereby bringing local voices and local perspectives into strategic decision-making and into the monitoring and evaluation of those strategies. We hope that other national and international climate change strategic processes will find similar ways to build in the views of local communities.

ICTs are cost-effective in evidence-gathering for climate change strategies. The experience of conducting an eSurvey as part of the Views from the Frontline project has shown that this method of surveying is valuable for mapping as it achieved a wide geographical coverage cost-effectively. As a component of a climate change strategy this approach may be valuable as the impact of climate change is highly variable at the local level, such that detailed mapping based on local knowledge and experience can generate valuable information on which to shape practical implementations of adaptation strategies. As a consequence bodies such as the World Bank ICT group have expressed interest in understanding the methodology in order to apply it for other wide scale surveys.

Recognise the value of direct interaction and engagement; but consider hybrid approaches. Mobile phone surveys are able to gather data from large samples at low cost. Face to face surveys are able to overcome barriers of literacy and discrimination. However, when face to face surveys are conducted by an active, local partner, they can engage constructively with communities to work for change. The combination of respondent scope and local community mobilisation in the original VFL survey approach has proved effective in equipping partners with the evidence needed to lobby national institutions and to guide international institutions. Therefore, it seems inadvisable to "throw the baby out with the bathwater" and move to a totally ICT-based approach. Instead, some kind of hybrid may be most effective – with face to face work providing reach, engagement and qualitative data; and with mobile-based eSurveys providing a low-cost broader base of more quantitative data.

Consider how to build mobile into the process. The cost benefits of using mobile technology for surveys are huge, so it is worth exploring mobile-based systems to see if they can help. VFL has demonstrated the technology but needs to refine the approach and learn how to use it more effectively. There is increasing interest in the use of mobile-based surveys (and other means of gathering citizen data, such as crowdsourcing) for informing disaster risk reduction policy, climate change strategy and for monitoring programmes; there is also a growing number of mobile-based data collection tools (e.g. Frontline SMS, OpenXData, RapidSMS).

Choose languages carefully in ICT-based surveys, and do not assume English is the wrong choice. Making surveys accessible to people of local language groups is an expensive issue for any research programme – questionnaires may need to be translated, and local teams of enumerators need to be recruited. Texting is becoming ubiquitous, and it was interesting to learn that English is being adopted as the language of texting in several countries. (For example in Bangladesh people texted in a basic English vocabulary in preference to Bengali, which required multiple keystrokes). This does not mean that texting can overcome literacy barriers, but it does indicate that cross cultural research using mobiles may become easier than expected.

Match sampling approaches to strategic purposes. The differences between face to face and eSurvey approaches forced VFL to think more critically about sampling. GNDR and Txteagle believe that the eSurvey sampling methodology can be improved to successfully target vulnerable individuals. This can be done by developing a restricted range of indicators to identify target respondents; a set of selection rules can then be applied to create a sample of a given composition using a two part survey. A broad sampling strategy is more likely to be appropriate for scoping activities such as disaster preparedness mapping, whereas sampling specifically targeted populations is more likely to be relevant to monitoring or specific design activities e.g. looking at discrete geographical areas.

Assess whether what you ask is what respondents hear. When, as in the eSurvey, there is no interaction or dialogue during the survey it becomes important to perform user testing to establish whether the responses reflect an understanding of the questions as intended. For instance it was noted that the responses to individual indicator questions were relatively similar, and consultation with network members highlighted that since all questions started with the words 'does local government . . .' people tended to answer them as a question about the general performance of local government.

Consider the potential of UCMP technology. Although data indicates that UCMP was effective in overcoming some of the barriers associated with the SMS survey, some questions remain unanswered. There were issues of compatibility of the technology with physical infrastructure in different countries, so it is not clear how widely it could be used. People were not familiar with UCMP in the same way they are able to use SMS, so respondents could find it confusing e.g. with interrupted UCMP sessions not storing text responses entered earlier. As UCMP was experimental, Txteagle were addressing technical difficulties as they arose, so responses to the survey reflected a combination of user experience and technical issues. It would make sense to further explore user behaviour once the technology is more stable.

Data Sources & Further Information

This case study is drawn from the experience of GNDR in running the VFL survey and reporting process over two cycles in 2009 and 2011. The process was managed by the network secretariat and implemented by members of the network across the globe. As noted above, the cost of conducting the surveys in 2011 was US$1.3 million (n.b. this does not include contributions in kind made by partners), and was funded by institutional donors including SIDA, the Swedish International Development Cooperation Agency, and USAID's Office of Foreign Disaster Assistance. Terry Gibson (terry.gibson@globalnetwork-dr.org) is Project Manager for GNDR, and Nigel Scott (nigel@gamos.org) analysed the survey data.

Based on their experience with mobile phone-enabled surveys, GNDR intend to use them again in future surveys. The next VFL survey is likely to be a more in-depth survey covering a broader range of indicators. If interest in VFL continues to grow, then the survey is likely to grow further e.g. to 100 countries. There is also some discussion of the possibility of mobilising interest and 'social demand' at local level in different ways in the next phase of VFL, so eSurveys may be applied in different ways to generate engagement with campaign-type activities.

The eSurvey process has generated a lot of interest from other agencies e.g. UN and the World Bank – partly because it is innovative. It is difficult to gauge interest among Participating Organisations because there is no role for them in the eSurvey process, so they have not been engaged.

- Global network website: www.globalnetwork-dr.org
- Resource area (including full VFL reports and full data analysis): http://www.globalnetwork-dr.org/views-from-the-frontline.html
- Txteagle (now renamed Jana): www.txteagle.com / www.jana.com

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F2. Supporting Strategic Decision-Making on Climate Change Through Environmental Information Systems: The Case of ENVIS

Author: Ushakiran Madari

Initiative Overview

Climate change is an imposing challenge faced across all continents. Emerging economies like India are no exception, with climate change impacting not just agriculture but rural ecosystems more broadly and urban environments too (Govt of India 2008). India has some advantages, though, in being able to learn from the mistakes and experiences of the industrialised world, and to take advantage of new technologies; including information and communication technologies (ICTs).

ICTs have a multiple relationship to climate change. On the one hand, the ICT sector itself and operation of the technology is estimated to contribute c.2 percent of global carbon emissions (Houghton 2009). On the other, ICTs could play an important role – through 'smart' applications – in reducing the carbon footprint of sectors sourcing the other 98 percent of emissions. ICTs will also have an important role to play in development of adaptive capacity (Ospina & Heeks 2010). But in this case study, the focus in not specifically on mitigation or on adaptation, but on ICTs' relation to a third strand of the connection between climate change and development: strategy; that is, the formulation of government policies, civil society initiatives and other high-level plans to address the challenge of climate change through e-enabled awareness and capacity building.

The key requirement for strategic decision-making is good information and, with this objective, the Environmental Information System (ENVIS) was set up in 1982 in India. It was significantly strengthened in 2002 through stronger institutional networks and updated ICTs with the support of the World Bank's Environmental Management Capacity Building Technical Assistance Project (EMCBTAP). ENVIS is a network of distributed subject-area centres seeking to support integration of national efforts in environmental information collection, collation, storage, retrieval and dissemination. It is basically a clearinghouse mechanism providing pointers to distributed environmental information for decision makers, policy planners, scientists and engineers, researchers, etc.

As of 2011, ENVIS consisted of 76 network partners all located in India (http://envis.nic.in/envis_list.asp), of which 46 are subject-specific, encompassing information on the following areas:

- Environment and Energy Management
- Ecology and Ecosystems
- Flora, Fauna and Conservation
- Environment Law and Trade
- Media, Environment Education and Sustainable Development
- Chemicals, Wastes and Toxicology

The remaining 30 partners fall into the "State of Environment" category, comprising those who provide information for the individual States in India on topics such as: eco-friendly technologies, coastal ecosystems, carbon and other emissions, green buildings, renewable energy, National Action Plan on Climate Change, etc.

Most partners have an ENVIS-specific website (often in addition to their own corporate site), intended to act as a portal for environmental information. Some 20 of these address climate change and the underlying causes of climate change with information on topics such as clean technology, renewable energy, ecological conservation, as well as on climate change itself.

Application Description

ENVIS is a largely decentralised system consisting of the focal point located in the Ministry of Environment and Forests, and the chain of 76 network partners: a set of institutions throughout the country which host an ENVIS Centre. The physical infrastructure hosting the Centres' ENVIS-specific data is a storage area network of India's National Informatics Centre (NIC), using Internet Information Server as the platform together with MS-Access and MS-SQL 2008 databases. Figure 1 shows the intended infrastructure of ENVIS, providing secured information on climate change and other issues through its portals.

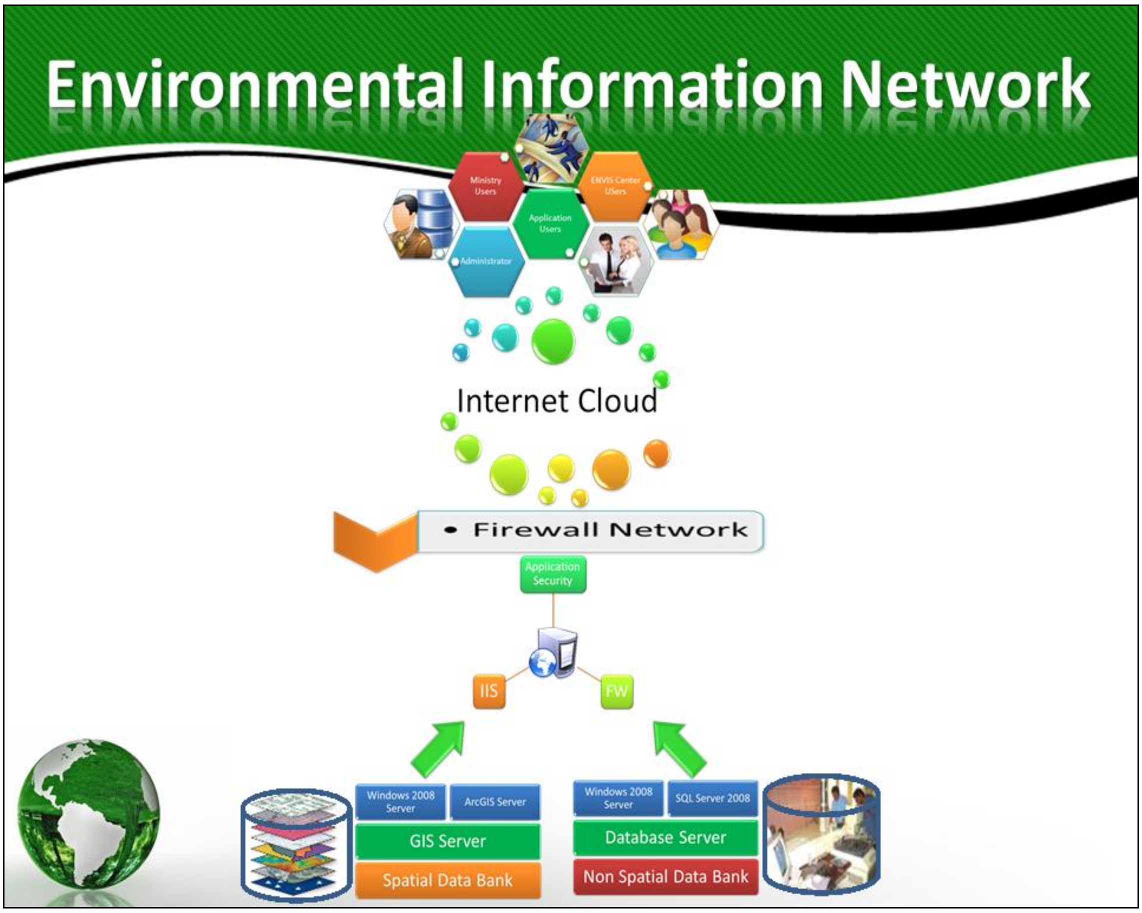

Figure 1: Outline of ENVIS (source: NIC)

NIC provides a secure channel for partners to update their ENVIS-specific websites through a virtual private network. Outwith ENVIS, but feeding into its content, GIS and remote sensing technologies are utilised by some Centres to monitor and compare different climate change-related parameters. ENVIS has developed a comprehensive database known as the Indian State-level Basic Environmental Information Database (ISBEID: http://164.100.194.5:8080/isbeid/) with 17 modules on various environmental subject areas to assist the State ENVIS Centres.

As noted, individual ENVIS Centres often operate their ENVIS-specific website in parallel to their organisational website. One example of an active ENVIS Centre website is that of the Energy and Resources Institute (TERI) - http://terienvis.nic.in/. Well-supported by the parent Institute, this site contains information on renewable sources of energy and green buildings, and provides GIS-supported maps on energy consumption etc. Some Centre sites also attempt outreach and engagement through interactive discussion forums, "kids' corners" and the like.

Formal Drivers and Objectives/Purpose for ICT Usage

The initial driver behind ENVIS in the 1980s was much broader than just climate change; being a more general concern with the growth of environmental issues – particularly pollution and conservation – and the need for some co-ordinated means of accessing information. In 2002, with the World Bank's EMCBTAP support, the ambit of ENVIS got broadened to include a greater focus on climate change. ENVIS got a further climate-specific fillip in the same year, when COP8 – the annual international climate change meeting – was held in New Delhi. The value of this focus has been confirmed subsequently with growing awareness of the current and future negative impact of climate change; and the need for information has grown steadily as more and more organisations in public, private and NGO sectors develop strategic plans that are focused on, or incorporate, climate change. ENVIS was set up to help meet this kind of information need. ICTs are now an essential foundation for this activity; particularly as information users increasingly expect – and demand – quick access to user-friendly and interactive information.

Stakeholders

The central stakeholders are the focal agency – the Ministry of Environment and Forests – which hosts the ENVIS Secretariat, and the National Informatics Centre. Then there are the network partners, forming the ENVIS Centres, who are drawn largely from a mix of State-level Departments of Environment and Pollution Control Boards, research-oriented or environment-oriented NGOs, and university institutes. The intended recipients of information from the Centres vary from partner to partner, but would include government policy-makers, local NGOs, planners, firms with commercial interests in climate change and the environment, scientists/engineers, and concerned individuals.

Impact: Cost and Benefits

The annual ENVIS budget is approximately US$1.5m, with much of the money devolved to the individual partners to pay for their ENVIS Centre work; each one receiving somewhere in the region of US$13,000 per year. Initial investments for capacity building included expenses for hardware, website design and content development. Subsequent funding has covered the salaries of an ENVIS co-ordinator and an IT assistant who undertake website maintenance, updating of content and databases, and engagement of stakeholders through interactive forums. Funding also covers training, travel and consumables.

The benefits of ENVIS itself should be seen as those of coordination and scale economies; enabling the individual Centres to develop and disseminate information on climate change and environmental issues to their target audiences. The ENVIS websites of the partner Centres vary significantly. Some no longer appear to exist; many exist but are clearly in need of updating; and a few are active and providing what should be valuable information. The example of TERI's ENVIS site was noted above, and the Centre for Media Studies - http://cmsenvis.cmsindia.org/ - provides a current guide to environmental news.

More typical examples include:

- The ENVIS site of the Institute of Tropical Meteorology - http://envis.tropmet.res.in/index.htm - provides climate change and other information that could be used by policy makers, but might more likely be seen as introductory educational material. The portal has poorly-designed static information that needs to be updated and a "Kid's Corner" that was non-functional at the time of writing.

- The ENVIS site of the Madras School of Economics - http://envis.mse.ac.in – is fairly well-designed, and contains a useful introduction to environmental economics. The portal does, though, require content updating in relation to policy briefings and newsletters.

The ENVIS website itself - http://www.envis.nic.in/ - could be strengthened with new publications, initiatives to increase its reach, updated interactive forums and result-oriented stakeholder discussions for inputs on key policies. Overall, and at the time of writing, the content age is mixed with some frozen in 2006 alongside updated material relating to recent (2011) meetings.

Evaluation: Failure or Success

At the time of its 2002 upgrade, ENVIS no doubt performed an important function. It cemented a network of organisations working on environmental issues, and led a number of the partner organisations to expand their remit to include climate change and associated information as part of their thematic area. It created a base of information that fed into COP8, and which also encouraged greater participation with that event. And it provided a number of partner organisations the technological means and support to develop their own websites and reach out to a wider audience.

Figure 2: ENVIS-Related Evaluation Meeting

Since that time, it is clear that ENVIS' role has been more challenging, as institutions have built their own ICT and web infrastructure, enabling them to interact directly with their client constituencies. There have been reports and meetings (e.g. see Figure 2) that are constituency focused. However, overall, it is impossible to judge the most important intended impact: whether ENVIS-supported information has been used for strategic climate change decision-making. It certainly was in 2002 at COP8. For many of the websites – which are not actively updated – it currently seems unlikely that they are having much impact. Some individual partners for individual issues – such as production of "State of the Environment" reports by some of the State-level Centres that include issues like energy use and climatic conditions, such as the TERI-based material on fuelwood consumption, or such as the Institute of Tropical Meteorology's CO_2 emissions inventory – may have been of value and/or may provide a valuable baseline for future use.

The ENVIS Secretariat does have ambitious plans: it has initiated a "State of Environment Atlas" which contains spatial information on environmental parameters; access to mapped socio-economic and natural resource information; and an interactive geo-spatial website highlighting status and trends of environmental parameters, with tools for more interaction. The Secretariat has also proposed development of a dedicated ENVIS Centre for climate change which would bring together all climate change-related activities of the current ENVIS Centres in the network.

Enablers/Critical Success Factors

The **expertise of partner organisations** is central to whatever impacts ENVIS can lay claim to. It is through these organisations that any data of value is generated and, perhaps at times, utilised for strategic decision-making related to climate change and other environmental issues.

NIC's informatics expertise has been a necessary component; most particularly in the early stages of the 2002 upgrade when partners had to rely heavily on NIC for both technology and skills. It will also be central to any future upgrade plans.

Constraints/Challenges

Low motivation and low user-orientation are reflected in the failure to update much of the ENVIS Centres' website content, and in poor website design. These feed into a negative spiral – users coming to the sites will have difficulties finding the information they want and/or will find material to be outdated or with dead links and functionality. As a result, users will not come to the site, creating few pressures to improve.

These issues, in turn, relate to **lack of self-sufficiency** of the Centre websites, with some partners apparently happy to receive funds when provided, but unwilling to take on their own responsibility for the sites. In part, in certain cases, one may see a philosophy that the websites are not for the partners, let alone for users, but are created "for ENVIS".

Despite ENVIS' laudable attempts to create a co-ordinated network, including subject-specific sub-groups and ENVIS co-ordination meetings, there is still a **strong sense of "stovepiping"**; that is a lack of integration in a number of areas. In part, this was deliberate – attempting to foster local ownership, the Secretariat gave freedom of design to the ENVIS centres without seeking to centrally control and intervene. The result is a lack of consistency in website design and content, and absence of integration in content, so users have to trawl through individual websites rather than finding materials at a single source, as they would no doubt wish. ENVIS itself has also been somewhat disconnected from climate change initiatives within other departments of the Ministry of Environment and Forestry. Overall, this illustrates the challenging tension between devolved control and ownership versus data integration for network-based climate change information systems.

Finally, the project has also faced **informatics challenges**, ranging from the difficulty of getting all network members to use newer ICTs (particularly members in lower-level government departments), to the lack of "green IT" awareness within ENVIS itself, such that no energy accounting or benchmarking is yet undertaken for the project.

Recommendations/Lessons Learned

User participation – that is, participation of the decision-makers, planners, etc. who will use climate change information – is essential when planning information systems to support strategic climate change decision-making. A first step would be to ensure design starts with a thorough user information needs assessment, but this can still backslide during implementation and operation. Therefore, what is needed is user participation throughout – the identification and involvement of a small group, who could ensure a steadfast attendance to the only people who really matter: those who will use the climate change information.

Project and policy engagement. As a companion to the first point, here the recommendation is that some means be found to get those within the individual data-providing locations (the ENVIS Centres in this current case) engaged with practice in some way. This could be providing information for a local project – perhaps a contentious one in which there are concerns about climate change mitigation, or in which adaptation to climate change is central. Or it could be providing information for a particular piece of climate change legislation or policy. All this helps focus those responsible for information systems on the needs of local users, and on ensuring the relevance and accuracy of the information they provide for that purpose.

Base projects on motivation and incentives. The difference between ENVIS Centre websites that are up-to-date and useful, and those which are not, is largely an issue of motivation of those involved. Climate change strategic information design is therefore not just a matter of matching content and design to user needs. It is also a matter of motivating – hence, of incentivising – the information system / website manager and clerical staff. This is not (just) a question of money, but also of broader motivations – seeing a value in the work being done; being recognised; etc. For example, a best website award that is popularised and coveted could be part of that process.

Embrace newer technologies. By and large, ENVIS has so far been designed around Web 1.0 technologies and Web 1.0 mindsets that – at best – broadcast static text. There are examples of forays into more powerful and more recent technologies, but climate change strategic information systems need to more fully embrace Web 2.0 and other high bandwidth-enabled technologies as broadband steadily diffuses in the developing world. Tools and support for video-conferencing and remote collaboration need to be widely disseminated and publicised so that system users make better use of them; allowing interaction between strategic decision makers, and between the decision makers and data providers, thus driving up the value and utilisation of information. Social media needs to be used to more effectively engage user populations (at least among the general public).

Data Sources & Further Information

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Data for this case study was gathered via interviews with NIC, the ENVIS Secretariat and a number of individual ENVIS Centres. The author was associated with one of the ENVIS Centres herself, developing online reports on climate change, the Clean Development Mechanism, and other topics; and co-ordinating interactions on climate change, including use of ENVIS as a vehicle to strengthen stakeholder interaction during COP8. In addition, use was made of ENVIS evaluation reports undertaken by the ENVIS Secretariat; presentations by the NIC and ENVIS Secretariat, and secondary data from those ENVIS Centres with an emphasis on climate change.

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F3. Building the Evidence Base for Strategic Action on Climate Change: Mexico City's Virtual Climate Change Centre

Author: Olinca Marino

Initiative Overview

Mexico City – also known as the Federal District – is located in the lower part of the Mexico Valley Basin, a naturally enclosed depression in the Mexico City Metropolitan Area (MCMA). The MCMA comprises the 16 boroughs of Mexico City – with a population of nearly 9 million people – and 34 municipalities of the State of Mexico that raise the total population to more than 20 million; roughly one in five of the country's citizens (INEGI 2010).

As the focus for national economic activity, Mexico City is a major contributor to greenhouse gas emissions (NYCG 2010). Around 88% of all such emissions in Mexico City are attributed to energy consumption in the form of fossil fuels and electricity used in transportation, industry, trade, housing and services.

The effects of climate change are already being felt (World Bank 2011). Lankao (2010) explains this has meant an increase in average rainfall as well as an increase in frequency and intensity of extreme events such as floods, droughts and heat waves. Over the centuries, the City has faced a succession of dry and wet periods in a dynamic equilibrium. However, the combination of land use and climate change has disturbed this equilibrium, heightening the risk of – among other things – flooding and landslides. The Federal District is also suffering an increasing "heat island" effect with extreme temperature events (Jáuregui 2009). As shown in Table 1, alongside these intense events will also come future changes in average weather patterns (INE 2010).

	Total annual precipitation change	**Mean annual temperature increase**
2020 scenario	+5 and -5%	Between 0.8 and 1.2°C
2050 scenario	+5 and -15%	Between 1.0 and 2.0°C
2080 scenario	-5 and -20%	Between 2.0 and 4.0°C

Table 1: Projected Changes in Precipitation and Temperature in Mexico City

The Mexico City Government has identified a number of strategic adaptive actions that need to be taken to react to these climatic changes (GDF 2008). Short-term, extreme event-related actions include: implementation of a metropolitan hydro-meteorological monitoring and forecasting system; micro-basin management of urban ravines; assistance to people who are identified as specifically vulnerable to extreme climate events; epidemiological monitoring; protection and recovery of native crops; and remote detection and monitoring of forest fires during the dry season. Actions for a medium-term response – which also encompass actions on mitigation of emissions – include: growth and improvement of public transportation and the transformation of vehicle technology; the efficient use of energy in buildings, industrial facilities, public lighting systems, water pumping systems, and homes; the exploitation of renewable energy sources; the rational use of water, as well as the reduction of waste generation and the promotion of an effective waste management system.

But such strategic actions require a sound evidence base, and also the opportunities for discussion among relevant stakeholders. In order to support this, in 2008, a Virtual Centre on Climate Change was created (*Centro Virtual de Cambio Climático de la Ciudad de México – CVCCCM*). The rationale for the Centre was that it would provide not just evidence and advice to policy-makers, but also help inform broader society – always enabled by ICT-based networks and other digital tools (Conde et al. n.d.). The working schema for CVCCCM is shown in Figure 1.

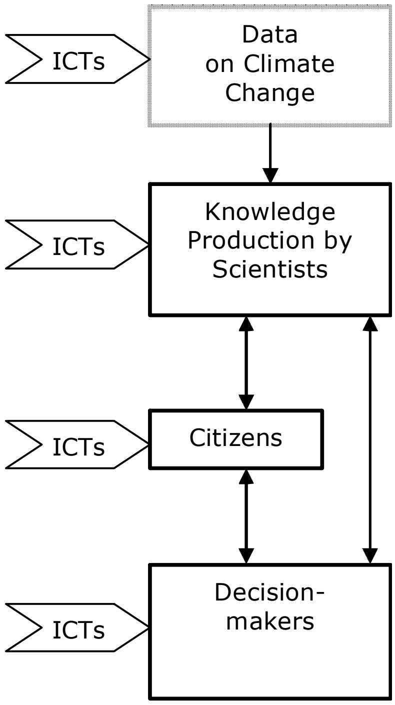

Figure 1: Overall Working Schema for Virtual Centre on Climate Change

The Centre's initial knowledge production tasks included the following:

- Assessment of City air quality, its impact on health and its relation to climate change.
- The effects of temperature, its interaction with ozone and hospital admissions.
- The impact of climate change on water availability in MAMC.
- Assessment of energy consumption scenarios and greenhouse gas emissions produced by the transport sector in MAMC.
- Impacts in MAMC related to solid waste under conditions of climate change.
- Vulnerability of conservation areas to climate change, and possible adaptation measures.
- The economics and politics of climate change.
- Poverty as a risk factor in implementation of public policies on climate change.
- Greenhouse gas emission reductions in MAMC.
- The history of climate and precipitation patterns in the Mexico Valley Basin.
- Popularising climate change science via social networks.

Based on the results of this work, the Centre has been able to make very detailed scientific proposals around climate change and water, air and ground resources; the health sector; public services; and land use planning (Ospina et al. 2011).

Application Description

As would be expected for a virtual organisation, CVCCCM makes extensive use of ICTs; particularly its website but also email for communication between participants, and e-science and GIS applications for modelling and mapping climate change effects and predictions. These are, in the main, the applications that can be seen as mediating the Figure 1 chain from data to knowledge production by scientists. However, in this section, more detail will be provided on the more general use of ICTs –

summarised in Figure 2 – which was trialled as part of the project on popularising climate change science (Meneses 2010).

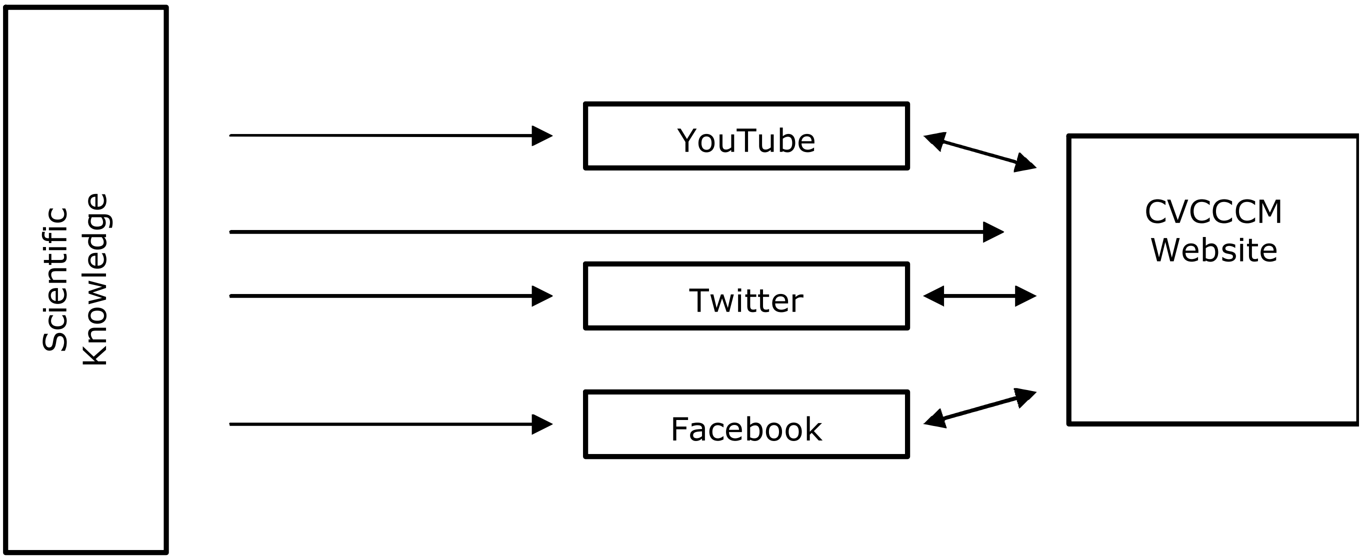

Figure 2: CVCCCM Digital Applications

Looking at each of the components in more detail:

Website: The webpage www.cycccm-atmosfera.unam.mx/cvccccm/ (see Figure 3) went online in August 2008, initially fed with material from the Atmospheric Science Centre of the National Autonomous University of Mexico (UNAM): databases and climate scenarios with their respective mappings. The site has information in Spanish on research studies, activity reports of seminars and workshops, plus news, videos and maps with scientific models of temperature and precipitation. By late 2011, the site had logged just over 43,000 visits since 2008, averaging between 12 and 15 per day. 91% of visits originated from within Mexico, 3% from the United States, and the rest from other Latin American countries (Y. Puente, personal communication 2011).

Figure 3: CVCCCM Website

YouTube: CVCCCM has a YouTube channel (see Figure 4) (www.youtube.com/user/CVCCCMvideo#p/u) with eleven videos. This channel was opened in November 2010 and by late 2011, it had received more than 2,000 viewings in total. Most of the content is CVCCCM researcher interviews on issues related to climate change in Mexico City, for example: future risks, vulnerability of poverty zones, mitigation in industry and trade, impact of climate change on vegetation, the relationship of climate change to air pollution, and climate change and public policies.

Figure 4: CVCCCM YouTube Channel

Twitter: The twitter account (http://twitter.com/#!/CVCC_CM) started operation in October 2010, accumulating 741 tweets by mid-2011 with some 690 followers. Tweet production has been variable on a daily basis, and has been in abeyance since May 2011.

Facebook: CVCCCM joined Facebook in October 2010. A total of 163 persons "like" the Centre's Facebook page. Environmental organisations and governmental officials were tracked and invited to become friends on Facebook and followers on Twitter. Others were accepted who by their own initiative came into this social network (Meneses 2010).

Apart from the above applications, blog and web for mobile were initially considered, but were not taken forward.

Formal Drivers

The main driver for the Centre has been the urgent need to act on the already present environmental impacts provoked by climate change in Mexico City (C. Gay, personal communication 2011). Local authorities have had to deal with extreme events related to the urban heat island such as heat waves, heavy rainfall and resulting floods, and reduced water availability associated with severe droughts in the catchment basin from which the city supplies part of its water demand (Conde et al. n.d.). No mechanism existed through which decision-makers and academics could meet to resolve city-wide issues linked to climate change (C. Gay, personal communication 2011). No simple communication bridges existed between these two sectors. CVCCCM and ICTs were introduced to help strengthen the task of data monitoring, evidence provision, and to facilitate strategic actions around adaptation and mitigation.

Objectives/Purpose for ICT Usage

The overall purposes of the Virtual Centre were three-fold:

- To build an entity that concentrates and organises the information regarding climate change effects in Mexico City, as well as coordinating research efforts on the subject;
- To support the continuous development of public policies that aim to increase adaptive capacity and reduce vulnerability of different social sectors;
- To create an Adaptation, Vulnerability and Mitigation Policy Framework for Mexico City.

The Centre was created as a virtual entity in order to reduce costs and to enable research scientists to remain embedded within their existing institutions.

Looking specifically as the social networking project outlined above, the intention was to promote active participation of a diverse group – not just CVCCCM researchers but other academics, journalists, students, and citizens – in CVCCCM activities, and more generally to help develop the culture and community around climate change and the environment in order to foment constructive debate, exchange of information, and active reflection (Meneses 2010).

Stakeholders

The CVCCCM is the product of a preliminary collaboration between the Atmospheric Science Centre of UNAM and the Science and Technology Institute of the Mexico City Government (GDF). It also involves additional public, academic, and research institutions, as listed in Table 2.

Name	**Public Institution**	**Academic and Research Institution**	**Present in CVCCCM website**	**Involved in research projects**
Centro de Investigación y Estudios Avanzados, CINVESTAV, del Instituto Politécnico Nacional		*	*	
Centro de Investigación y Estudios Superiores en Antropología Social		*	*	
El Colegio de México		*	*	
Comisión de Recursos Naturales	*		*	
Bomberos	*		*	
Facultad de Ciencias, UNAM		*	*	
Facultad de Economía, UNAM		*	*	*
Facultad de Química, UNAM		*	*	
Instituto de Ingeniería, UNAM		*		*
Instituto de Geología, UNAM		*		*
Instituto Nacional de Salud Pública	*			*
Instituto Tecnológico de Estudios Superiores de Monterrey		*		*
LOCATEL-GDF	*		*	
Proclimas, Instituto Politécnico Nacional		*		*

Procuraduría Ambiental y del Ordenamiento Territorial	*		*	
Programa Universitario de Estudios sobre la Ciudad, UNAM		*		*
Pronatura México A.C. (NGO)			*	*
Secretaría de Finanzas-GDF	*		*	
Secretaría de Desarrollo y Equidad para las Comunidades-GDF			*	
Secretaría del Medio Ambiente-GDF	*		*	
Secretaría de Obras y Servicios-GDF	*		*	
Secretaría de Seguridad Pública-GDF	*		*	
Secretaría de Salud-GDF	*		*	
Sistema de Aguas de la Ciudad de México	*		*	
Universidad Autónoma de la Ciudad de México		*	*	
University of California, Riverside		*	*	
Universidad Autónoma Metropolitana		*	*	
Universidad Iberoamericana		*		*

Impact: Cost and Benefits

CVCCCM ran in two funded phases, from 2007 to 2009, and from 2009 to the end of 2010. Total costs (the majority of which were provided by the City's Science and Technology Institute) were around US$700,000 of which around half was spent on administration and one-third on the specific research projects (Gay & Martinez 2011).

The Centre's main tangible benefits have been the development of scientific knowledge around the climate change topic areas listed in the Overview, and production of 18 study reports including proposals for government. As noted, ICT – via email, e-science applications, GIS, etc has enabled these reports to be produced. It also enabled virtual attendance at workshops and discussions which were held in-person. And it disseminated all reports and other outputs via its website.

As already noted, its social network project created videos and Facebook/Twitter dissemination, though the associated numbers in terms of home page visitors, video views, etc have been relatively low.

Evaluation: Failure or Success

As a collaborative venture supporting evidence-based strategic actions for climate change, the Centre has had some successes in terms of knowledge and institution building. It has shown that the multiple relevant institutions can work together in a multidisciplinary way; with 50 organisations submitting research proposals during the two phases, 30 being registered with CVCCCM, and with more than 20 participating in both the development and dissemination of climate change research.

Within the research process, ICTs have been invaluable – they have been central to data capture, data processing, data presentation and (to some degree) dissemination. Thus ICTs have helped create a new set of specific information on climate change effects, causes and strategic actions for adaptation and mitigation in Mexico City. Tangibly, this is seen in a set of 18 study reports – five of which have been formally published as books; documentation of meetings and workshops; and two documents of diverse proposals for Mexico City decision-makers. There has also been some use of ICTs to disseminate climate change evidence to a wider audience via social networks, though – as seen – the extent of this dissemination has been somewhat limited.

Where ICTs have not particularly been used has been to create a broader dialogue that breaks out of the confines of scientific institutions, and a community of strategic practice. There has been no ICT-enabled dialogue between scientists, decision-makers and civil society, and the other stakeholders have not been engaged with – nor have they contributed to – the social media applications. Essentially the scientific community has focused on production and presentation of their results, but has not sought – whether via ICTs or other means – to engage others, or to engage with the formulation and implementation of the strategic actions which their work points to. It is therefore, for example, unclear whether City decision-makers have made any use of the materials produced.

Enablers/Critical Success Factors

The **virtuality** of the Centre is an important part of what it has been able to deliver. In many countries, there are few – if any – dedicated centres dealing specifically with climate change. In addition, climate change has such a wide-ranging effect that it will always require multi-stakeholder, multi-disciplinary approaches to research strategic evidence and actions. Trying to create a new research institution, and draw staff away from existing institutions would create political frictions and resistance. Making the Centre virtual, and allowing staff to remain within their existing institutions avoided this problem.

Drawing on the **best-renowned, most highly-experienced institutions** to form the collaborators of the Virtual Centre was beneficial in two ways. First, by drawing on such a wide range of experience, the quality of the Centre's climate change research was assured. Second, the reputational capital brought by the collaborating institutions, helped lend credibility to the research outputs.

Incentives to collaborate are always vital for a virtual entity, and in this case they were provided via the mechanism of the funded research projects, which motivated the various institutions to engage. Finally, **ICTs** were essential to both the functioning of the Centre overall but most particularly to the scientific research process.

Constraints/Challenges

The **academic mindset and academic priorities** are a difficulty, because what scientific institutions demand of their researchers and what they also value (for example when considering promotion) is the production of research papers (Conde et al. n.d.; Aguayo 2011; Bonfil 2011). Therefore many of the aspects of the Figure 1 model are challenged. Researchers often see their responsibilities coming to an end on production of their research paper. They have little time or motivation for participating in social networks; and when they do it is often in "broadcast" rather than "interaction and engagement" mode. They have little time or motivation for engaging with decision-makers; an activity that would help ensure their research had impact. They have not sought to tailor their materials to particular audiences – for example, to differentiate scientific, policy and general audiences. And some do not even engage with the effort of trying to disseminate their papers. One further result has been the lack of web and other updates since completion of the project's second phase.

Prioritisation of climate change varies over time. After COP16 was held in Cancun, for example, there seemed to be good general awareness within the population, and also a desire for action among policy-makers. However, more recently, the extreme outbreaks of violence and general sense of insecurity have pushed this issue instead to the top of the policy and citizen agendas. More generally, policy-makers are often focused on immediate problems and find it hard to find time for longer-term issues such as climate change (despite the evidence of present effects).

Finally, the **digital divide** still exists and constrains the ability of the general population and also community-based organisations to participate with online activities, especially those that are bandwidth-heavy like video. Less than 10 percent of the population has access to broadband and more than 70 percent lacks Internet access altogether (Duarte 2011; TyN 2011).

Recommendations/Lessons Learned

Incentivise climate change researchers to engage with policy-makers and others. The production of scientific reports is of some intrinsic value, and it does help to build knowledge. However, much of its potential value is lost if the work does not have some impact on policy and practice. As seen, this is only likely to change if there are incentives for scientific researchers. Such incentives can be project specific – for example, assessment criteria within proposals that require an impact plan including specific details on how the researchers will engage with policy-makers and provide support to policy formulation and implementation. It would require a far greater scope of change, but incentives could also be more systemic – for example, by including assessment of knowledge transfer and research impact in the promotional criteria and institutional evaluation schemes that cover relevant research institutes.

Foster integrated tri-partite climate change research which does not just tack dissemination activities to the end of the project, but which seeks – from the start – to involve not just researchers, but also policy-makers and civil society organisations. These other groups can then have a role in shaping the climate change research agenda, in ensuring the validity and transparency of ongoing project implementation, and in the production of project outputs.

Customise use of ICTs to climate change audience, purposes and context. Climate change research institutions are generally well-provisioned with ICT – at least relative to the general population – and able to use the range of e-science applications for the whole research lifecycle, from data gathering through processing to dissemination. But ICTs must be used appropriately. Where broadband is lacking, then meetings and discussions may need to be held face-to-face, with ICTs as an adjunct. And ICT formats and content must be customised. Academic reports will not suit a general or policy-making audience – short briefings, interactive demonstrations, GIS/map-based graphics, audio and visual presentation may all be more relevant.

When using social media, aim for interaction on climate change not broadcast. The CVCCCM was innovative in including a social media project, but there is a sense in which this was operated with a Web 1.0 not Web 2.0 mentality. In other words, reports were simply placed on the website, videos made by the researchers were placed on YouTube, tweets were broadcast. What was needed instead, was a plan for interactive use of the digital tools; use that would engage with and listen to the wider stakeholders in climate change. Examples might have been a more general climate change space in which others could upload videos, post reports, blog and comment, and so forth.

Data Sources & Further Information

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The information presented on the Virtual Centre on Climate Change has been obtained from published materials of the CVCCCM; from data appearing in its digital applications; and from personal interviews with members of the Centre.

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F4. PRECIS: Regional Climate Modelling for Adaptation and Development Planning

Authors: Martin Mahony and Mike Hulme

Initiative Overview

The PRECIS system (Providing Regional Climates for Impacts Studies) is a package consisting of a regional climate model (RCM) and software allowing the processing and display of data on a personal computer. The system is provided free of charge to scientists in developing countries through partnerships between the UK's Meteorological Office Hadley Centre and governmental bodies at the UK and international level. The system is intended to provide developing countries with information on possible future changes in regional climate in order to facilitate adaptation and developing planning, and thus falls under both the 'strategy' and 'adaptation' domains of relation between ICTs, climate change and development (Ospina and Heeks 2010).

Application Description

Figure 1: The Main PRECIS Operating Window

The PRECIS system comprises the Hadley Centre's regional climate model, HadRM3P, and a software package enabling the processing and display of data on any computer running the LINUX operating system (see Figure 1). HadRM3P is closely related to the Hadley Centre's global atmospheric model, HadAM3P, a version of the atmospheric component of the Centre's coupled global model, HadCM3. The regional model has a maximum spatial resolution of 25km, with nineteen vertical levels in the atmosphere and four in the soil, and can be located over any region of the globe. Input data to the model are provided by the Hadley Centre, and results from other global models are increasingly being used to drive the regional simulations in addition to outputs from the Hadley Centre's own global model. Climate change projections are generated using scenarios from the Intergovernmental Panel on Climate Change's (IPCC) 'Special Report on Emission Scenarios', which provide assumptions of future economic growth, technological changes, population growth and changes in governance.

Formal Drivers and Objectives/Purpose for ICT Usage

The PRECIS project is very much motivated by concern about the possible future impacts of climate change and the need to develop adaptation policies in light of scientific predictions of the future. Many developing countries are seen as being the most vulnerable to the impacts of climate change, yet the majority of scientific knowledge concerning future changes is generated in Western nations. The project has therefore sought to begin redressing this geographical imbalance by enabling modelling work to take place within the national contexts where the simulation results will be put to political use. The simulations are intended to provide input to climate impact and vulnerability studies which in turn feed into the preparation of National Communications to the UN Framework Convention on Climate Change (UNFCCC) as required under articles 4.1, 4.8 and 12.1. The project also contributes to the UK's need to partake in technology transfer initiatives as dictated by Article 4.5.

Stakeholders

The key driver of the project is the Hadley Centre which developed the model and the user software. The Hadley Centre is a subsidiary of the UK Meteorological Office which deals with scientific issues relating to climate change. The core funding comes from the UK's Department for Environment, Food and Rural Affairs and the Department of Energy and Climate Change, and the Centre features a number of internationally renowned climate scientists making significant contributions to the assessments of the IPCC. During development of the PRECIS system, contact was made with the United Nations Development Programme (UNDP) regarding the alignment of the modelling project with the need to assist countries in planning for climate change adaptation. The UNDP's National Communications Support Unit, which assists countries in fulfilling their UNFCCC obligations, provides many of the resources necessary for training prospective PRECIS users. The project is also supported financially by the UK's Department for International Development (DFID) which assists particularly with the training exercises, and the Department for Environment, Food and Rural Affairs, reflecting the model's perceived ability to facilitate scientific capacity building and to ultimately assist in the reduction of societal vulnerabilities to natural hazards. At the user end, the model has been taken up most commonly by governmental science agencies in non-Western countries (usually meteorological institutions) that have scientists with the necessary climatological expertise to use the model productively, in addition to institutional links to climate and environmental policy makers.

Impact: Cost and Benefits

The model is made freely available to scientists in countries which fall outside of the Annex I grouping under the UNFCCC, i.e. countries which are not classed as 'industrialised'. Training is provided to prospective users by the Hadley Centre at no cost to the new users due to the financial support of DFID, UNDP, etc. Around three international training workshops are conducted each year (in addition to one UK-based workshop), with prospective users gathering at regional centres to receive instruction and often building collaborative working relationships with scientists in neighbouring countries. This programme has made the system very attractive to scientists who otherwise would not have access to this kind of model which is the product of years of development at the Hadley Centre.

The benefits of this wider distribution of scientific capacity and expertise therefore include the ability of developing country scientists to develop scenarios of future climate change on spatial scales which are perceived as being highly relevant to decision making. However, in interviews with users it became clear that the main advantage of the system is not necessarily the ability to develop policies based on detailed scientific information but, rather, is the generation of awareness of possible climate change impacts in policy communities. The detail which can be provided by the model renders the issue of anthropogenic climate change 'visible' – i.e. changes can be visualised on scales of geographical familiarity – and is thus an effective means of persuading decision makers of the need to act. For example, despite work with PRECIS and the exploration of modelling uncertainties in the Caribbean being limited by a lack of computational resources, this has not precluded simulation results from use of PRECIS being used to support the Caribbean Community's calls for a 1.5°C cap on temperature rise on the international stage.

Evaluation: Failure or Success

The wide uptake of the model certainly renders the project a success in the terms of project's instigators. Over 100 countries are now running the model (see Figure 2), and results have appeared in numerous policy documents related to UNFCCC processes (e.g. Taylor *et al.* 2007; Natcom India 2008) and scientific publications (e.g. Alves and Marengo 2010). However, if the project were to be evaluated from a purely scientific standpoint, then further questions arise. For example, it is not commonly accepted within the modelling community that one global climate model can be 'downscaled' through a regional model with equal reliability in all areas of the globe. Global models always perform 'better' (i.e. they recreate elements of the observed climate with greater accuracy) in some regions than in others. It is therefore very difficult for a scientist working with just one regional model to assess the performance of the model in their area of interest against other techniques or other models.

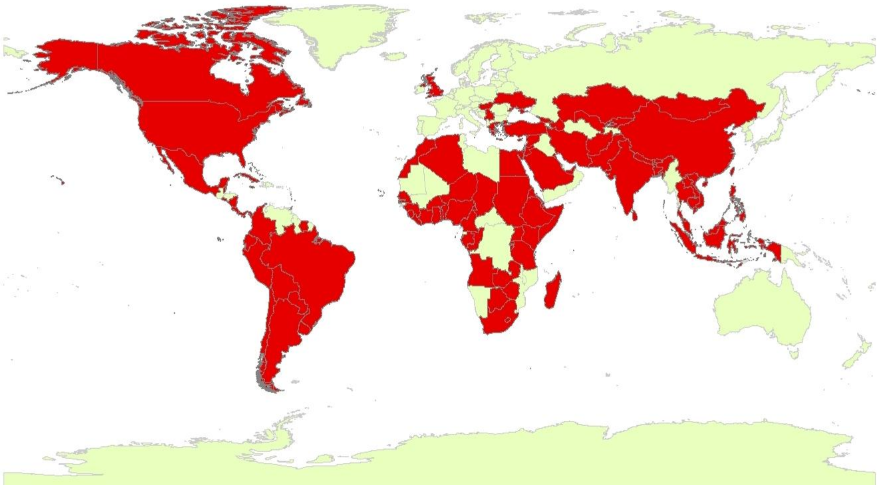

Figure 2: Map Displaying Countries with Institutions Trained in the Use of PRECIS
(c) Crown Copyright 2009, the Met Office.

It is perhaps too early to judge the substantive impact that the modelling activities have had on national policy making despite some examples of model results being used to bolster certain political decisions such as in the Caribbean, where model results have been used to inform the selection of a wind and solar-powered saltwater reverse osmosis system on the island of Bequia to ease anticipated future water shortages, to give one example. In India, a country with a long-standing record of collaboration with the Hadley Centre, the model has provided the scientific basis for the Indian Network of Climate Change Assessment (INCCA) which seeks to deliver scientific assessments of the impacts of climate change on India, independently of the work of the IPCC which is seen as not serving the interests of India as best it might (see INCCA 2010). The project can therefore be judged to have been successful in providing a new level of scientific (and perhaps by extension, political) autonomy to countries running the model, but this includes a number of caveats which are discussed below.

Enablers/Critical Success Factors

The provision of the model **free of charge** and the provision of approximately ***in situ* training** has enabled a large number of institutions to take it up. It is also clear that the prominent **international reputation of the Hadley Centre** has helped the model to achieve such widespread use. Documents relating to the model position the Hadley Centre as a "pioneer" of this "most proven method for obtaining detailed predictions" (MOHC 2001:2). The **alignment of the modelling project with countries' requirements under the UNFCCC** was also important in the widespread uptake of the model, and key actors have spoken of the significance of the UNDP's 'seal of approval' in encouraging countries to obtain the model and pursue the related line of work. The successful proliferation of the model cannot be explained simply by the usefulness of it as a tool for adaptation planning. It is the authoritative institutional assemblage which surrounds the model – in the form of the scientifically influential Hadley Centre and its politically influential project partners such as UNDP – which has arguably been a key characteristic enabling it to travel so widely around the world.

Constraints/Challenges

As mentioned above, **relying on one model for projections of future climate over a particular region can be problematic**. A common way of assessing the reliability of model results is to perform multiple 'runs' of the model to test for variations and sensitivity to different initial conditions (e.g. different scenarios of future greenhouse gas emissions) and patterns of natural climate variability. This strategy was recently applied using the same atmospheric model to assess whether anthropogenic climate change had contributed to recent flooding events in the UK (Pall *et al.* 2011). The study used distributed computing (the model was run on a network of volunteer computers), allowing the researchers to draw on thousands of model runs with different model configurations in the calculation of probabilities of whether the risk of such flooding events has been raised already by climate change.

This study highlights how computationally demanding it is to develop probabilistic scenarios and to fully evaluate the uncertainties in climate simulations. Scientists running PRECIS with limited resources are restricted in their ability to employ such techniques, so **assessment of the uncertainties which are inherent to any projection of the future is a very difficult task**. Throughout the duration of the project, the Hadley Centre has given increasingly greater prominence to issues of uncertainty in regional climate modelling. This has been manifest in both accompanying documents and the training programme. However, published results from PRECIS work have demonstrated the difficulties faced in fully exploring prediction uncertainties through the use of one RCM with limited computational resources.

This therefore raises the question of the positioning of the model in relation to political decision making. Does the provision of this model potentially encourage decision makers to pursue policies which would provide 'optimal' adaptation to the future climate envisioned by the model? It is widely accepted that the most successful adaptation policies will be those that are *robust* to a whole range of possible futures and their inherent uncertainties (Dessai *et al.* 2009). By **adapting to just one possible scenario** (e.g. a certain decrease in annual rainfall), societies may leave themselves vulnerable to alternative futures. Given the uncertainties of the climate system it is difficult to claim to be able to predict the future so reliably as to guarantee the success of 'optimal' adaptation strategies. There are therefore risks in placing models such as PRECIS at the centre of efforts to adapt to possible future changes.

Recommendations/Lessons Learned

How can models like PRECIS therefore play a role in the pursuit of robust adaptation policies? **Prediction must be re-conceived** from a 'limit' to adaptation (i.e. the position that "you cannot adapt without precise predictions"), to **an enabler of political discussion** about present vulnerabilities and how they may be modulated by changing political and social conditions. Models can play a useful role in stimulating ideas about how our societies may cope with a changing climate, and in adjudicating over which possible futures may be more or less likely. Under such an approach, **the key 'limit' to adaptation is not our knowledge, but our institutional and societal capacities** to reduce vulnerabilities to environmental stresses. Such a re-conception of the role of climate models demands contemplation by all stakeholders of the weight they give to predictions of the future, and particularly of how models are 'sold' as packaged solutions to the problem of envisioning and adapting to an uncertain future in diverse places.

There are of course great challenges in meeting the demands of international ICT technology transfer, which could be met in the future by **increased end-user involvement in the design of such modelling systems** which may eventually lead to the emergence of more autonomous, diverse and locally-tailored approaches to studying future climates across different national or regional contexts. However, this would depend not only on greater deliberation and design flexibility (the majority of users cannot currently alter the model or software to better suit local needs), but also on tempering the emphasis which is placed on predictions as a means of driving policy by the sorts of institutions which have helped establish PRECIS as a popular tool of climate prediction.

Data Sources & Further Information

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The research informing this case study was conducted through analysis of 47 key documents relating to the PRECIS project, the majority of which are publicly available. Six semi-structured interviews were also conducted with both model developers and users, in addition to a more informal discussion with the PRECIS team at the Hadley Centre. For more information on the PRECIS project, see http://www.metoffice.gov.uk/precis/.

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