



SMART VILLAGES
New thinking for off-grid communities worldwide

Indigenous communities, ICT and rural development: case studies in Tanzania and Sarawak, Malaysia

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Smart Villages

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

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INTRODUCTION

The vast majority of the rural development literature focuses on relatively homogenous ethnolinguistic communities based in peri-urban and middle-rural areas. This literature has borne much fruit and there is now a general consensus among academics, practitioners and policy makers on the broad parameters of what is required to catalyse rural development in these areas, though the realisation of such development in practice continues to present challenges. The same cannot be said for indigenous communities. Often located in extremely remote areas, many indigenous communities rank among the most marginalised communities in the developing world and there is little theoretical and empirical study of the relationship between indigenous communities and rural development.

We contribute to this nascent literature by conceptualising the relationship between indigenous communities and rural development. We begin by assuming that a key consideration in understanding the relationship between indigenous communities and rural development is a recognition that many indigenous communities aim to balance outside influences with the consolidation of traditional organisational structures and culture. We illustrate the relationship between indigenous communities and rural development using the Thunen model. The Thunen model is able to explain the economic activities of rural communities at a particular time through a vector of economic distance. Usefully, the Thunen model is also able to explain the ways in which innovations are able to alter this vector of economic distance.

In the original application of the Thunen model in 19th century Germany, it was the introduction of a national railroad network that altered the vector of economic distance. While not detracting from the fundamental importance of physical capital and the impact that, for example, good roads can

have on the rural development trajectories of indigenous communities, there has been much discussion on the impact that information and communications technology (ICT) can have on rural development in remote communities (e.g. Unwin 2009).

We suggest that carefully executed information and communications technology (ICT) projects have the potential to alter the vector of economic distance for remote indigenous communities thereby both strengthening and expanding the set of economic activities undertaken. We test this hypothesis through careful study of three different ICT projects in indigenous communities located in Tanzania and Sarawak, Malaysia. Our first case study examines a community radio station in the Maasai village of Terrat in Tanzania. Our second case study focuses on a telecentre in the Kelabit village of Bario in Sarawak, Malaysia. Our final case study looks at how ICT has been used to augment traditional botanical knowledge in the Penan village of Long Lamai in Sarawak, Malaysia.

Our data were collected over the period June 2014 to November 2015 through site visits, focus group discussions, semi-structured interviews and a literature review. Site visits included visits to households, community facilities, schools, small businesses, community radio stations, telecentres and utilities. Semi-structured interviews were undertaken with 30 key informants. Consistent with the qualitative approach of our study, we used a snowball sampling procedure to identify the 30 key informants interviewed. These included village leadership, village-based business owners, community service providers, household heads and spouses, as well as academics with a track record of collaborative research in the communities. Focus groups and workshop discussions were undertaken in each of the three community halls, and focused on the role of ICT in community development. Our survey

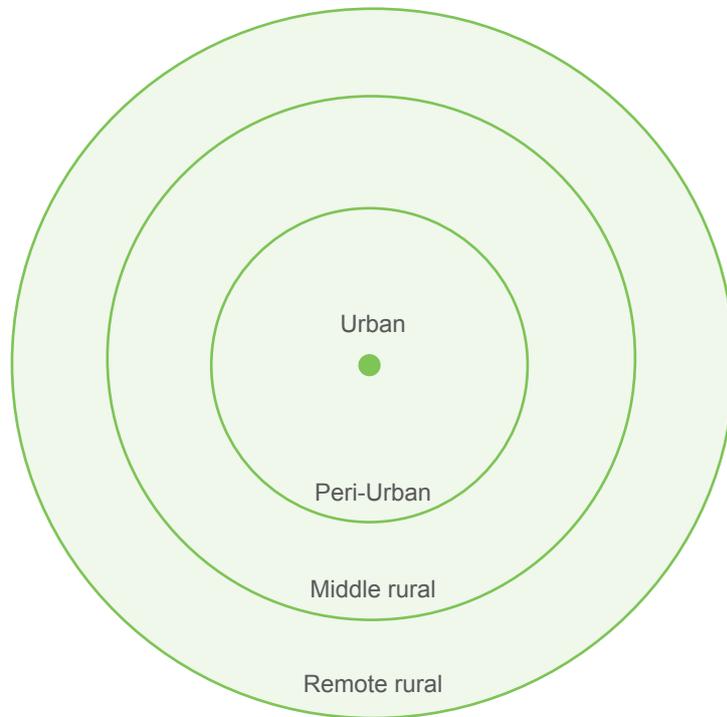
of the literature consisted of reviewing related anthropology, history and political economy peer-reviewed literature and the grey literature on the

Maasai communities in northern Tanzania and on the Kelabit and Penan communities in Borneo.

INDIGENOUS COMMUNITIES, ICT AND RURAL DEVELOPMENT

The Thunen model (figure 1) of economic location provides a useful framework to understand the relationship between indigenous communities, ICT and rural development. In the Thunen model, rurality can be understood as remoteness from an urban centre and is therefore measurable along a vector of economic distance (Hite 1997). Moving outwards from an urban centre in concentric rings, the Thunen model shows that there are degrees

of rurality. The first ring refers to rural areas that are located relatively close geographically to the urban centre. These are rural areas that are often considered peri-urban. Moving further out, the second concentric ring captures what can be conceptualised as middle rural areas. The final ring represents remote rural areas (Wiggins and Proctor 2001).



Peri-urban	Middle rural	Remote rural
High value commercial farming	Commercial farming	Subsistence farming
Employment in urban centre	Rural industry	Tourism
Rural industry	Tourism	

Figure 1: Thunen model and typically associated economic activities
Based on Hite (1997) and Wiggins and Proctor (2001)

The Thunen model suggests that there is an economic disadvantage of distance that increases the further away rural communities are from urban centres. This economic disadvantage manifests itself through limiting the available set of stylised economic activities. For peri-urban areas the set of economic activities tends to include high-value commercial farming, employment in urban centres and rural industry. For middle rural areas, the set of activities includes commercial farming, light rural industry and tourism. Remote rural areas – the most economically disadvantaged by distance – tend to be limited to subsistence farming and tourism (Hite 1997; Wiggins and Proctor 2001).

There is an argument to be made that the rural development literature has been dominated by a focus on peri-urban and middle rural areas. This is understandable given that the typical economic activities amenable to peri-urban and middle rural areas lend themselves well to rural development initiatives. A reading of the literature finds that this area of rural development is well enough developed that there is a general consensus that rural development in the peri-urban and middle rural areas can, at least in principle, be achieved through an integrated approach consisting of investment in physical infrastructure, extension services and business support programmes, education and healthcare. The exact mode of investment and implementation differs according to institutional capacity and context, however it is generally agreed that the approach must be mediated through champions at all governance levels to achieve maximum impact (see, for example, van Gevelt 2014a). In practice, however, the road to development is rarely as straightforward as theory would predict.

There is, however, no similar consensus on approaches to rural development in remote rural areas. This can be attributed to two main factors. Firstly, the economic distance from urban centres means that remote rural areas

are traditionally characterised by a limited set of economic opportunities. Secondly, in many developing countries a significant proportion of the communities that constitute remote rural areas are indigenous. Unlike more ethnically homogenous rural communities, indigenous communities tend to operate under a pluralistic institutional structure that sees interaction between traditional and state institutions. The addition of this complicated interaction variable complicates rural development initiatives and has the potential to result in unintended and sub-optimal outcomes (Larcom et al. 2016).

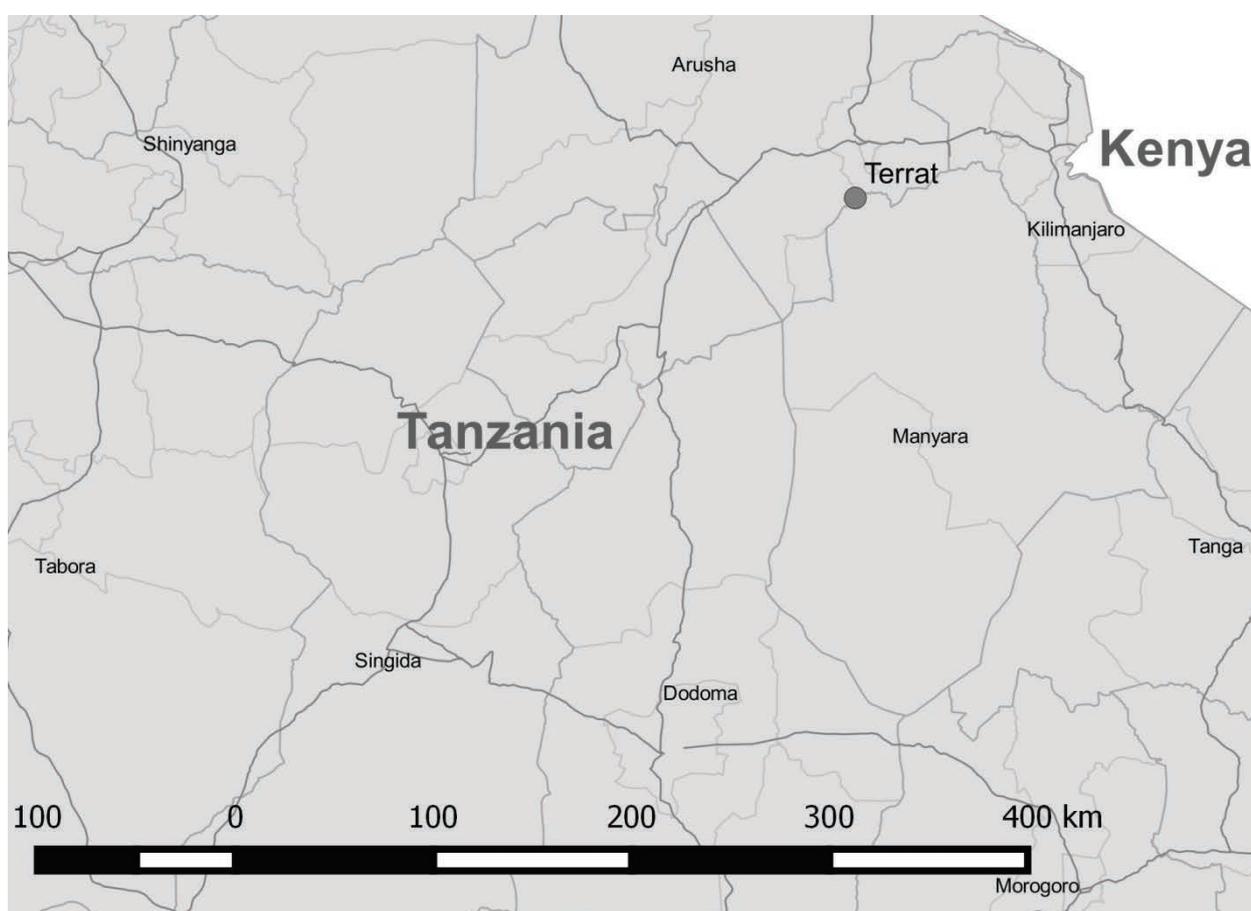
Despite the lack of attention paid by the rural development literature to indigenous communities, the field of Information and Communications Technology for Development (ICT4D) has devoted a sizeable amount of research on the role that ICT can play in improving the socio-economic outcomes of indigenous communities around the world through both empowering communities to find a balance between the consolidation of their traditions and culture and outside influences, and by reducing the economic disadvantage of distance. A broad term, ICT consists of devices ranging from radio and telephones to computers and the internet. Its proponents argue that this range of devices has the ability to benefit remote rural communities through the provision of education (eLearning), health (telemedicine/mHealth), employment opportunities (eCommerce) and a range of governance services (eGovernance) (Unwin 2009, Holmes and van Gevelt 2015, Yeo 2015).

In terms of the Thunen model, ICT can be conceptualised as an innovation with the potential to alter the vector of economic distance for remote communities both directly, through eCommerce, and indirectly through eLearning, mHealth and eGovernance. In turn, this can both strengthen existing economic activities and lead to the creation of a new set of feasible economic activities for remote rural communities.

CASE STUDY 1: ORKONEREI COMMUNITY RADIO – TERRAT, TANZANIA

Located in the Manyara region of Tanzania, the Maasai village of Terrat is a thriving hub of economic and social activity that caters to approximately 1,252 households residing in the village and in hamlets within a day's walk. Despite its remoteness, located approximately 90km from the nearest city, Arusha, and only accessible through unpaved roads, Terrat impresses due to households having access to reliable and affordable renewable electricity generated through a community-owned off-grid utility, a pioneering

and award-winning dairy processing industry, and the presence of an exciting cluster of small shops, hairdressers and tea rooms. Although it is difficult to see today, the transformation of Terrat from a struggling Maasai settlement to an exemplar in rural development for many of the Maasai community in Tanzania can be traced largely back to the transformative impact of a community-level radio station: the Orkonerei Radio Service FM.



Map 1: Terrat's location, in Northern Tanzania

Beginning in the 1980s, the Maasai in Tanzania faced significant challenges to their traditional pastoralist way of life due to, among other reasons: land grabs fuelled by investors eager to take advantage of the natural value of the plains by using the land for agriculture, biofuels and

tourism; more frequent and severe droughts; and an increased incidence of cattle epidemics (Nelson et al. 2012; Ykhanbai et al. 2014). In order to sustain their livelihoods, a significant number of young Maasai men turned to mining, petty trading, and agriculture or migrated to urban

centres. In villages like Terrat, this facilitated the introduction of a cash economy and introduced other elements of 'city-life' to the Maasai. Within the community of Terrat these changes sparked debate. Some argued that the cash-economy and modernism were signs of progress and development. Others argued that these changes threatened the survival of the Maasai people and their culture (Jallov and Lwanga-Ntale 2007).

In response to this, 21 of Terrat's inhabitants joined together and founded the Institute for Orkonerei Pastoralists Advancement¹ (IOPA) in 1991. A limited company with membership open to the Maasai community, IOPA can be thought of as, in effect, a service-oriented NGO with the objective of bringing about positive social, economic and cultural transformation to the Maasai in Tanzania through creating an informed pastoralist community. Initially, IOPA concentrated its resources on tackling the land grabs facing the Manyara region of Tanzania. Through raising awareness in Terrat about the indigenous land rights of the Maasai, IOPA proceeded to file a number of court cases against the Tanzanian government with the Tanzanian High Court ruling in favour of IOPA in a land mark ruling. The success of IOPA in addressing Maasai land rights inspired IOPA to help the community in and around Terrat adapt to changing environmental and socio-economic conditions through a pastoral livelihood programme and vocational training. These activities took place at a community centre located in Terrat and, as a result, were limited to a subset of the community who were able to overcome geographic and time barriers to attend sessions. It quickly became apparent to the founding members of IOPA that they would need a different means of communication to have a wider impact on the Maasai community, both within Terrat and in the wider Manyara region ((Jallov and Lwanga-Ntale 2007).

¹ In 2015, IOPA was recorded to have 1,084 Maasai members and 126 associated self-help groups (IOPA 2015).

Radio was seen as an ideal medium by IOPA, especially with over 80% of Terrat's residents being illiterate in the 1990s. The timing was fortuitous, with the international donor community seeing community-radio initiatives as a means of reducing poverty in Africa. IOPA was selected as one of three community-based organisations in the Swedish International Development Cooperation (SIDA) funded East African Community Media Project (EACMP). In the first phase of the project, from 1996 – 2002, SIDA provided funds for IOPA to set the foundations for a community-radio station. This involved undertaking technical and social surveys, writing a code of conduct, mobilising the community and procuring and installing the necessary infrastructure. A second phase, from 2002-2007 was approved to help the three community-radio initiatives consolidate. A third phase of funding was initially planned but was cancelled. This phase would have focused on transitioning the three community-radio initiatives into self-sustaining entities (Da Costa 2012).

Named the Orkonerei Radio Station (ORS) FM, it was not until the end of the first phase of funding in June 2002 that the first broadcast was made. This delay was attributed to the protracted process of obtaining a license from the Tanzanian government. Being the first community radio station in Tanzania, ORS FM was restricted to a broadcast radius of 100km, ensuring that only 10% of all broadcasting was in the Maasai language (Kimaasai), and was forbidden from selling airtime for financial gain (Conrad 2011; Ali and Conrad 2015).

Run by a team of volunteers, ORS FM broadcasted for up to seven hours a day during its second phase (2002 – 2007). As illustrated in table 1, the broadcasting schedule consisted of news (local, regional and global), programmes to raise awareness on particular health, education, legal and environmental issues. A weekly broadcast with callers calling in for legal advice, as well as a broadcast focusing on improving the efficiency

of managing livestock was also included in the programming. This was complemented by music (both Maasai and other genres) and greeting slots, where individuals phone in and announce greetings to others in the Maasai community. Particularly noteworthy, was a discussion programme titled “through the eyes of women”

that brought out female perspectives on issues in the traditionally patriarchal Maasai community. Contrary to the Tanzanian government’s requirements, a significant proportion of programming was broadcast in Kimaasai rather than the national language, Kiswahili (Jallov and Lwanga-Ntale 2007).

	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00
Mo.	-	News	Health	Greetings	Greetings	News	Music	-
Tues.	Music	Music	Education	News	-	News	Discussion	Discussion
Wed.	Music	Advice	Advice	Environment	Greetings	News	News	Music
Thurs.	Music	News	Health	Greetings	Livestock	News	Discussion	Discussion
Fri.	-	Music	News	Sports	Greetings	Greetings	Music	Music
Sat.		Women	Sports	Sports	Guest	News	Music	Music
Sun.		Christian	News	News	Christian	Greetings	Music	Music

Table 1: ORS FM broadcasting schedule during the second phase (2002 – 2007) of SIDA funding
Source: Based on Kariongi as cited in Jallov and Lwanga-Ntale 2007.

ORS FM is credited with having had a transformational impact on Terrat and the wider Maasai community. These impacts can broadly be disaggregated into three categories: consolidation of the Maasai identity; improvements in health, education and incomes; and improved governance and political participation (Jallov and Lwanga-Ntale 2007; Conrad 2011).

As previously mentioned, increasing interaction with the outside world had led to debate among the community regarding the identity and future of the Maasai. By providing a forum for people in Terrat and the wider Maasai community to communicate, ORS FM helped preserve elements of Maasai culture and traditions, especially the continued use of the Kimaasai language. At the same time, debates and discussions on topics such as women’s rights led to positive changes in

a typically patriarchal society. Public awareness broadcasts are credited by residents of Terrat as having improved health and educational outcomes, particularly among women and children. At the same time, broadcasts aimed at managing livestock are purported to have led to significant efficiency gains. Lastly, ORS FM has provided a medium for residents of Terrat and nearby areas to engage in the political process and ensure improved governance at the local, regional and national levels. A tangible outcome of this has been the negotiation of a successful payment for ecosystem services agreement negotiated by the residents of Terrat with a consortium of tourism companies (Nelson et al. 2009; Ykhanbai et al. 2014).

Perhaps ORS FM’s most significant impact, however, was indirect and unintended. Soon after

commencing its first broadcast, ORS FM struggled with high fuel costs with over 40 litres of diesel per day required to power the generator for its seven hour broadcast day. The high cost of diesel led IOPA to begin negotiations with the Tanzania Electric Supply Company and the Ministry of Energy and Minerals for an extension of the electricity grid to Terrat. A feasibility study was undertaken and extension of the electricity grid was seen as prohibitively expensive at an estimated cost of US\$ 340,000 (Batchelor et al. 2005). With the assistance of the Dutch Foundation Stichting Het Groene Woudt² (SHGW), IOPA established a community-level electricity utility. Technical expertise brought in by SHGW highlighted the potential for Terrat to make use of jatropha, a locally grown crop, as biofuel. A second-hand biodiesel generator along with jatropha processing machinery was brought in and provided the electricity for ORS FM.

Proving to be much cheaper than diesel generators, IOPA's community electricity utility not only allowed ORS FM to consolidate its 7 hour broadcast day, but allowed it to increase its hours of broadcasting to 15 hours a day. The transformational nature of affordable electricity was not lost on IOPA, with the positive example at ORS FM leading to the purchase of two additional biodiesel generators taking the total generation capacity to 300kW. Today, the generators are operational from 06:30 to 23:30 daily and provide electricity to 189 households, schools, a health centre, churches, eight boreholes, dairy processing facilities and small businesses, such as shops, bars, hairdressers, tea rooms, carpenters and welders.

Arguably most impressive is the development of Terrat's dairy processing industry. This was the result of IOPA and SHGW examining potential livelihood strategies given access to affordable electricity and the main resources available to the

community: milk and livestock. IOPA undertook an internal study to quantify the supply of milk during the rainy season—when milk is usually available in abundant quantities, and found that much of this surplus milk was being wasted. Processing milk into higher value-added dairy products, such as yoghurts, ghee and cheese, was seen as a feasible strategy. Investment in dairy processing facilities, as well as the training of women, was funded by SHGW. Today, between 1,000 to 2,000 litres of milk per day are processed and the finished products are sold both locally and in cities all over Tanzania and the East African region.³ Importantly, the entire dairy processing industry is run by women and has had a positive impact on improving gender equality in Terrat.

Despite its direct and indirect impact on the Maasai people in Terrat and its surrounding area, ORS FM has been at a crossroads since 2007. Because SIDA's third period of funding did not materialise, insufficient provision was made towards achieving self-sufficiency and scale. In order to survive, ORS FM increased its broadcast range to beyond a radius to 300km and now sells airtime for advertisements. It has also actively sought funding partnerships with UNESCO, John Hopkins University and a range of NGOs. This has brought ORS FM into conflict with the Tanzanian government and results in an annual fine for violating the community radio station broadcasting agreement. Discussions within the community continue regarding how to safeguard the future of ORS FM. This is likely to result in the reinvention of ORS FM as a business entity. There is debate about this as, although ORS FM will be able to operate commercially, many in the community feel they will lose ownership over ORS FM and that the many benefits of ORS FM will eventually taper off (Conrad 2011).

² *Stichting Het Groene Woudt is a Dutch family foundation with the mission of economically improving the livelihoods of marginal farmers in East Africa, India and Indonesia.*

³ *In 2014, Terrat's Gouda variety of cheese was recognised with an award of excellence from the Tanzanian Dairy Board.*

CASE STUDY 2: eBARIO TELECENTRE – BARIO, SARAWAK

Hemmed in by mountain ranges on the east and west, Bario is considered the traditional homeland of the Kelabit people. One of the smallest groups of Sarawak's 25 ethnolinguistic groups, the Kelabit number approximately 6,000 in total of which 4,500 now live in urban towns and cities. With roughly one thousand Kelabit within a day's walk, Bario serves as the Kelabit Highland's commercial and administrative centre (Amster 2006; Harris 2002; 2009). Consisting of nine hamlets, Bario is reachable from the nearest city only by 19-seater de Havilland Twin Otter aircraft operated by the Malaysian Airlines Rural Air Service or by a 12-hour four-wheel-drive journey on unsealed logging roads (Cheuk et al. 2012).

Little was known about the Kelabit until the British Army based their guerrilla operations against the Japanese in Bario during World War Two and used Bario as one of their main staging sites during the Indonesia – Malaysia confrontation (1962 – 1966). Subsequently, however, anthropologists have compiled a sizeable literature on Bario. According to Bala (2008), the Kelabit intrinsically embody a desire for progress and their interactions with the forces of modernity and development have very much reflected this.

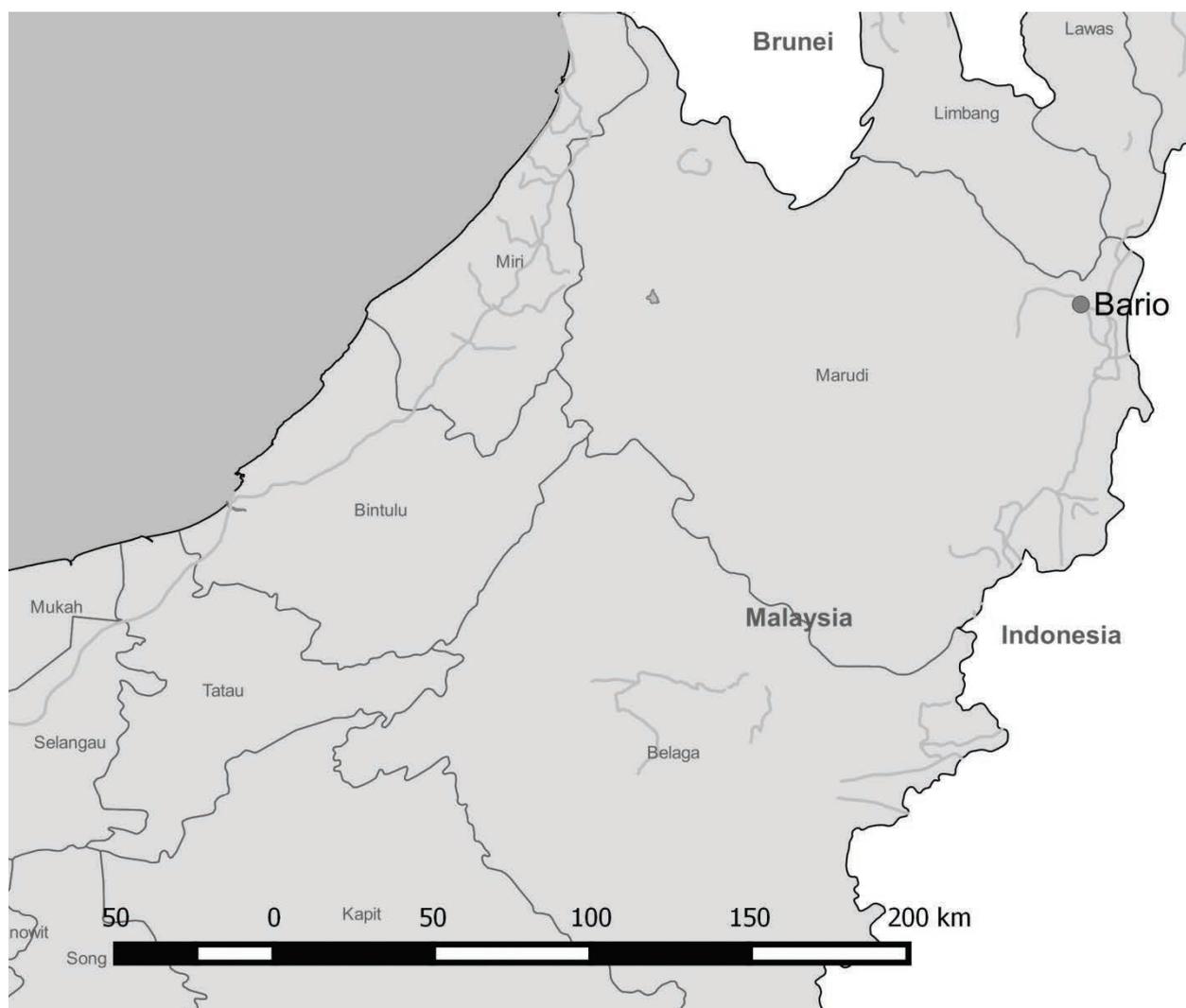
Today, the local economy of Bario is dominated by agriculture and tourism. Bario is endowed with fertile agricultural land and produces renowned rice, salt and pineapples. Its geographic remoteness, however, limits the market size for agricultural products with the vast majority of produce consumed and sold locally. Tourism has contributed to the Bario economy since 1985, when the first foreign tourist is recorded as coming to Bario (Jiwan et al. 2006). Tourists take advantage of Bario's access to large areas of primary rainforest. Trails through the rainforest range from a couple of hours to 12 days and allow

tourists to experience Borneo's rich biodiversity⁴ first-hand (Rodger 2005).

The Kelabit desire for progress has seen the people of Bario embrace education since construction of the first school in the Highlands in 1946. A desire to continue education, along with the economic opportunities offered in urban areas has resulted in a steady stream of out-migration from the Kelabit Highlands since the 1960s (Lee and Bahrin 1993; Amster 2006). On the whole, these migrants have performed disproportionately well with many Kelabit having achieved high-ranking jobs in industry and government (Amster and Lindquist 2005). This out-migration was accompanied by a need to maintain communication between the Kelabit in Bario and their kin in urban-centres. At the same time, an indirect effect of out-migration has been the desire to improve the socio-economic condition of Bario, both for the remaining residents and as a means to offer the youth an alternative livelihood to migration to urban centres. According to Amster and Lindquist (2005), this is important given that a small segment of young Kelabit men do not find urban life satisfying and choose to return to Bario.

Prior to the eBario telecentre, communication between Bario and the Kelabit in urban areas was through a radio service centre. Calls were made via very high frequency (VHF) radio services. Use of this technology, even with subsidies, was considered expensive by residents in Bario and the process arduous. This process consisted of waiting to book a call with an operator, who then placed a booking through a telephone operator based in Peninsular Malaysia. Provided the call did not drop, the operator would then connect the line (Harris et al. 2001; Tarawe and Harris 2009). Although Bario benefited from federal and state infrastructure (e.g. schools, health clinics, and an

⁴ This includes bioluminescent fungi, at least 42 varieties of wild orchids and the famous *Rafflesia*.



Map 2: Bario's location in the Malaysian state of Sarawak on the island of Borneo

airstrip), Bario's geographic remoteness made it difficult to improve the socio-economic condition due to the transportation costs associated with exporting agricultural goods and the high transaction costs involved in bringing tourists to Bario (Rodgers 2005).

Working together with the community at Bario, researchers from the Universiti Malaysia Sarawak (UNIMAS) implemented eBario: a state-of-the-art telecentre to connect Bario with the wider world and improve socio-economic development. Community buy-in into the telecentre was established through the creation of steering and management committees. These consisted of the Paramount Chief, as well as village headmen

and representatives from women, youth and the Church. All major decisions rested on the judgement of the steering committee, while the management committee was given responsibility for the operation of the telecentre. This process allowed UNIMAS' researchers to customize the services provided by the telecentre to the characteristics of Bario and its residents (Yeo 2015).

The eBario telecentre was sited on the commercial strip of Bario, nearby cafes, restaurants, shops and government administration buildings. The eBario architecture is illustrated in figure 2. To access the internet, very small aperture terminals (VSATs) were installed and connected to 10

computers in 2002. The signal was then routed via satellite to a hub station in the closest city, Miri. In addition, satellite public telephones were set up at the telecentre. As Bario did not have 24-hour access to reliable electricity, the eBario telecentre was initially powered by a diesel generator. The difficulty in obtaining a steady supply of diesel and the cost of diesel, however, prompted the research team to power the system through an innovative solar-diesel hybrid system. In 2006, the eBario telecentre was handed over to the community (Cheuk et al. 2012; Yeo et al. 2013).

The eBario telecentre has been transformational for Bario. Qualitative evaluations by Taware and Harris (2009) and Cheuk et al. (2012) found that the most significant tangible impact was the result of increased connectivity. Specifically, a cross section of Bario’s population (including the Paramount Chief, lodge operators, a local nature guide, a café operator and a business woman) stated that eBario brought the world to Bario

and put Bario on the global map through access to internet. More concretely, this translated into being able to communicate with relatives in urban areas through email or satellite public phones-a marked improvement over the previous radio-telephone services - and a significant reduction in the transaction costs of tourism.

As previously mentioned, Bario has experienced a steady trickle of tourists since 1985. With hospitality being a way of life among the Kelabit, the first tourists stayed for free at the home of the Paramount Chief. This continued until the Paramount Chief’s son realised that it was acceptable to charge remuneration for lodging and put a “guest house” sign on the front of the house. Over the years, a handful of other guest houses opened up to cater to tourists. Home stays in Bario operate an all-inclusive service that includes not only accommodation and meals, but also guides for treks in the forest. The flow of tourists, however, was severely limited due to

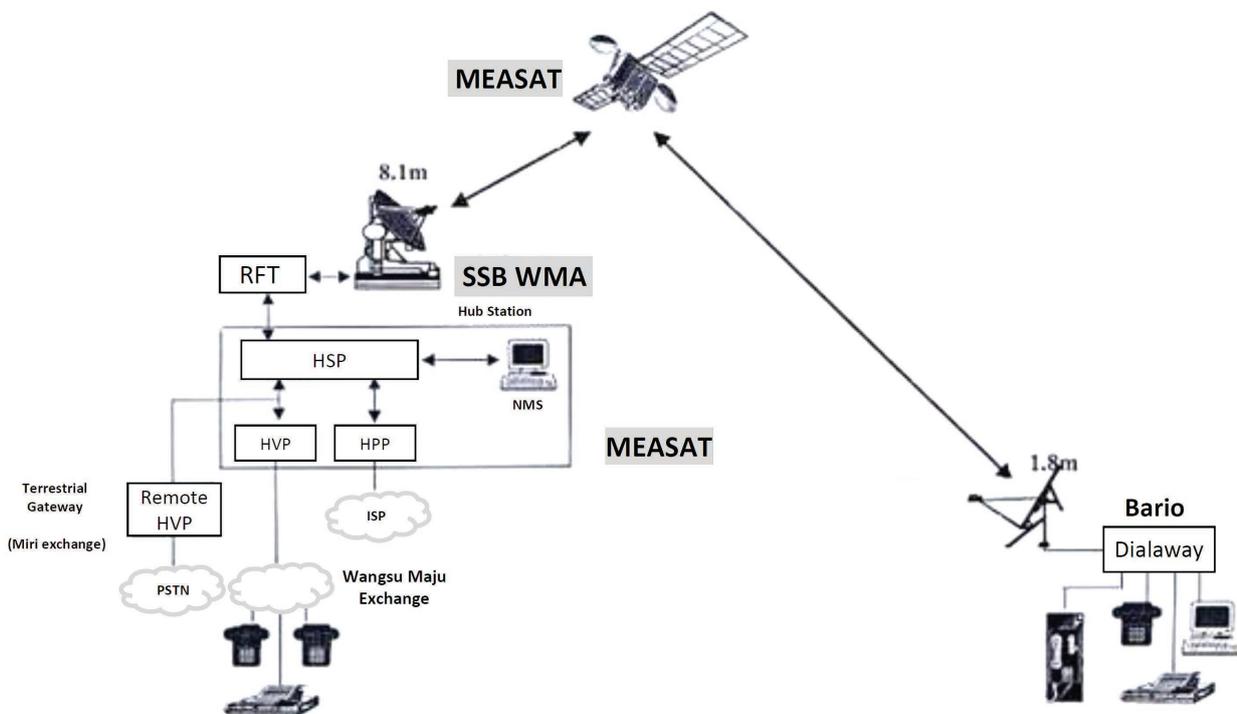


Figure 2: eBario architecture. Source: Zen et al. (2004)

high transaction costs with the tourists coming to Bario having to enquire through specialised travel agencies in Sarawak's main cities. Information was incredibly limited and it was difficult to make contact with home stays in Bario. At the same time, home stays in Bario were unable to market themselves to potential tourists (Rodger 2005; Harris 2009).

eBario, by providing access to the internet, benefitted homestays significantly. Homestays were able to list on Sarawak tourism websites and respond to direct enquiries from potential tourists. Homestays were also able to organise appropriate times for pick-up and drop-off at Bario airport and other important services. Furthermore, the internet was used to promote events such as the Bario Slow Cook Festival – an event which successfully draws in tourists from Sarawak, Peninsular Malaysia and abroad. In addition to homestay operators, guides have tended to benefit as a result of the increased number of tourists flowing into Bario. Beyond these two groups, however, Rodger (2005) argues that there has been little economic impact on other segments of the community at Bario.

The impact of eBario on tourism, however, has not met its full potential due to issues of technical and

financial sustainability. Specifically, the telecentre has struggled to operate continuously due to electricity constraints (Cheuk et al. 2012). This is largely attributable to the climate in the Kelabit Highlands, where it is not uncommon for heavy rain and cloudy weather to last for several days. This, along with the sensitivity of solar photovoltaic panels to wet and hot weather, means that there is insufficient time for the solar PV panels to charge battery banks (Anyi et al. 2010). Financially, the telecentre has struggled to cover operating costs since its handover to the community in 2006.

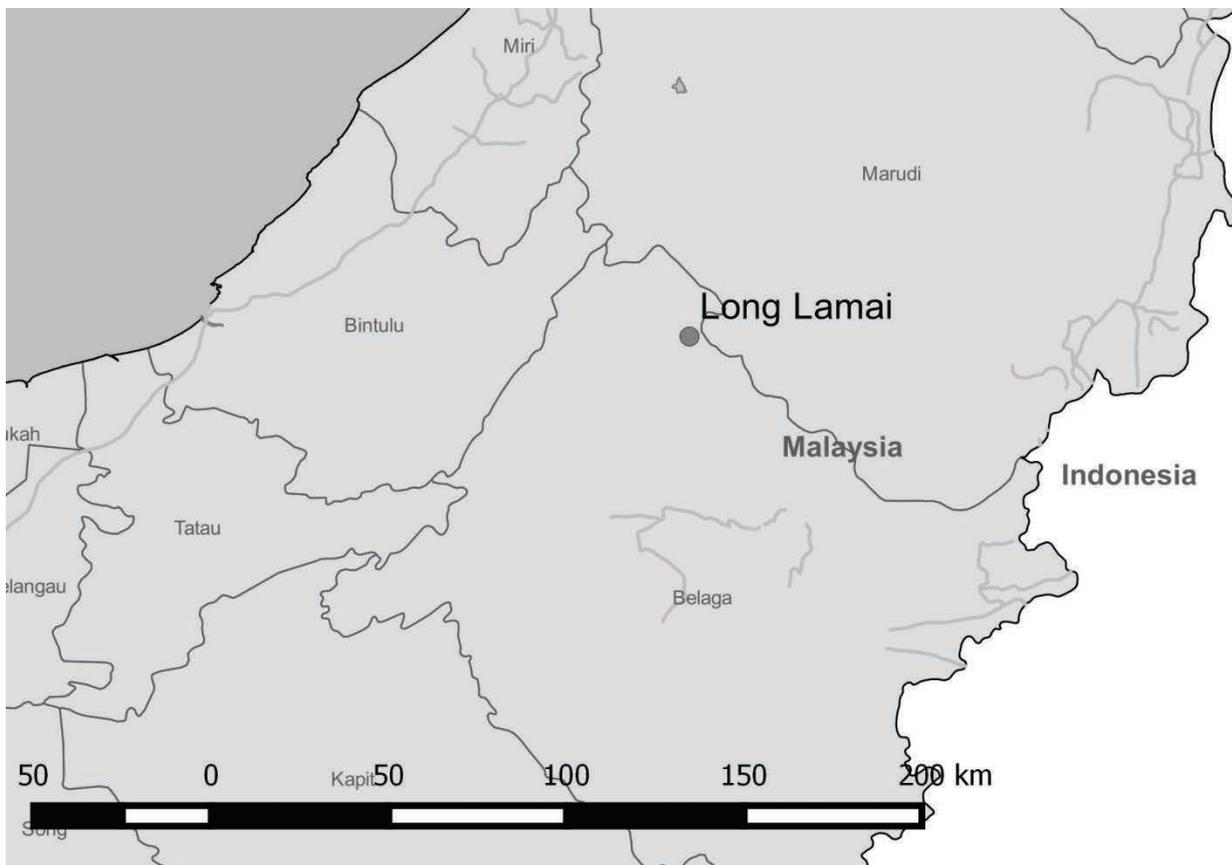
Now in 2016, the eBario telecentre continues to stand proud in the heart of Bario. According to the community, it has led to tangible benefits through connecting Bario to the wider world. The expansion of telecommunication networks in Sarawak, however, means that Bario's residents are now able to use mobile phones to communicate both by phone and through the internet on affordable data plans. Bario's needs have changed and to, a large degree, the telecentre has accomplished its goals. According to Tarawe and Harris (2009) and Cheuk et al. (2012), many of Bario's residents believe the telecentre should continue to play a role, but that it must be reinvented to address today's needs.

CASE STUDY 3: AUGMENTING TRADITIONAL BOTANICAL KNOWLEDGE WITH ICT – LONG LAMAI, SARAWAK

Long Lamai is a remote Penan village located in the Baram river basin of Sarawak, Malaysia. It is only reachable through a combination of twin-otter aircraft, four-wheel drive over logging roads, and a 90 minute boat ride through river rapids. The village has limited access to electricity through a 12kW run-of-river mini-hydro plant. There is not enough capacity for all households to be connected to the mini-hydro plant in the best of times. In the dry season, there are further limitations on electricity from the mini-hydro plant, and what electricity is available is used for public infrastructure, such as worship services at the Borneo Evangelical Mission Church. Some households run small 6 horse power diesel generators, but cannot afford to run them for long. There is no proper water supply and limited

telecommunication service, with a very weak signal from one telecommunication provider available from only certain spots in the village. As part of an initiative to replicate eBario in Sarawak, a telecentre stands at the centre of the village. It is regarded as transformational by the community due to the ability to communicate with the outside world through access to the internet and has led to the development of a nascent ecotourism industry.

With its 500 inhabitants, Long Lamai is one of the largest Penan settlements in Borneo (Zaman and Yeo 2013). Long Lamai was only permanent settled approximately 50 years ago, when many of Sarawak's Penan moved from a nomadic forest-dweller livelihood to a settled or semi-nomadic livelihood. As of 2010, national records suggest



Map 3: Long Lamai's location in the Malaysian state of Sarawak on the island of Borneo

that of Sarawak's estimated 16,281 Penan people, 77% were settled permanently, 20% were semi-nomadic and the remaining 3% still lived nomadic livelihoods (Lyndon et al. 2013). All Penan settlements, however, still depend on the forest for a wide range of non-timber forest products that provide, among other uses, food, medicine and construction material (Donovan and Puri 2004; Siew et al. 2013).

Today, the main livelihood in Long Lamai is subsistence farming with three households engaging in the homestay business for a small number of tourists every year. Like the Kelabit in Bario, the Penan in Long Lamai face challenges to their traditional way of life as a result of settling and due to Malaysia's rapid economic development. This has manifested itself most significantly in increased migration of the youth due to few economic opportunities beyond farming and the allure of urban life. This migration and the disenchantment of the youth with traditional Penan lifestyles have contributed to the loss of indigenous knowledge (Brosius 2006).

Originally forest nomads, the Penan possess an intimate botanic knowledge of the forest and its non-timber forest products. This is illustrated in table 2, with the Penan having catalogued at least 201 different species for food and potable water, 321 species for construction and tools, 90 species for medicinal use and 6 species for cultural use. Detailed ethnobotanic research further suggests that the Penan's botanic knowledge is unique and differs from that of other indigenous communities, such as the Kelabit and Iban (Koizumi and Momose 2007). Another distinctive characteristic of the Penan botanic knowledge is its transmission mechanism, with knowledge disseminated through *Toro*: an experience-based knowledge sharing activity between generations (Zaman et al. 2013).

Toro can be conceptualized as a journey into the forest through which younger males learn from elders the way of the Penan. This consists

Use value	Number of species
Food and potable water	201
Construction and tools	321
Medicinal use	90
Cultural use	6

Table 2: Non-timber forest products known by the Penan, classified by use value
Source: Based on Koizumi and Momose (2007:456)

of key activities, such as: finding a location in the forest with sufficient food and water resources; erecting temporary accommodation; and foraging and hunting for food. These activities are embedded with values of forest stewardship that are transmitted generationally. The centrality of *Toro* and knowledge of the forest cannot be understated, with the Penan adage that 'if you do not know about the plants, you are not a Penan' (Siew et al. 2013).

The transition from a nomadic to a settled livelihood for the Penan at Long Lamai combined with more interaction with an increasingly modernised Sarawak has threatened *Toro*: the transmission mechanism of botanical knowledge of the forest. For example, Zaman et al. (2013) report that elders in Long Lamai are increasingly reluctant to transmit indigenous knowledge to a youth that prefers to find their solutions from modern science and is increasingly likely to migrate to towns and cities. The impact of these changes on *Toro* means that without intervention this knowledge is likely to be lost completely (Koizumi and Momose 2007). Working with researchers from the University of Malaysia, Sarawak (UNIMAS) during the installation of the telecentre, elders at Long Lamai enquired about the potential for ICTs to assist in preserving their traditional knowledge through documentation. Discussion with four elders and four youths

that were selected by the community led to the development of eToro (Siew et al. 2013).

eToro is an open source software tool that has been customised to record picture, textual, audio and video data, as well as GPS coordinates. It has been created in a manner faithful to *Toro* and is designed as a tool through which elders and youth can venture into the forest and document botanical knowledge. This consists of three documentation activities: collection and documentation of data *in situ*, verification of the data at community meetings; and storing the data on an external hard disk drive. eToro is under the custodianship of a dedicated community-appointed manager. Access to the data is restricted, with only the manager afforded full access. Community elders are able to view all data, while the youth are unable to access data concerning the cultural value of plants in the database. Other users (e.g. botanists) are only able to use the software's search function and browse pictures of plants (Siew et al. 2013; Zaman et al. 2013).

In addition to cataloguing the Penan's botanical knowledge, eToro has encouraged the community at Long Lamai to look at how to harness their indigenous knowledge to improve their socio-economic wellbeing. Two activities being discussed within the community are using their indigenous knowledge to attract a niche market of ecotourists, and non-timber forest product (NTFP) commercialisation. Despite the telecentre providing the means to market Long Lamai as a tourist attraction, it is difficult for Long Lamai to attract tourists in the same way that Bario can given its relative geographical remoteness and the lack of transportation infrastructure in place. Realising this, the community at Long Lamai believe that marketing the intimate relationship

that the Penan have with the forest can help target a niche sector of tourists. Given that eToro contains picture, audio and video data, the community is discussing whether selective use of this data can help market and differentiate Long Lamai as a unique tourist destination in Sarawak.

The second activity being discussed as a result of eToro is non-timber forest product commercialisation. Widely acknowledged as having the potential to provide economic benefits to remote communities, NTFP commercialisation can prove to be a lucrative and ecologically sustainable economic activity if the high transaction costs characteristic of a thin market structure are addressed (van Gevelt 2014). This will require the identification of demand for niche market products and the development of a profitable value chain. Given Long Lamai's geographical remoteness and its high transportation costs, the community is investigating the potential of distilling aromatic NTFPs for potential sale in the luxury hospitality industry.

The example of eToro has shown how indigenous knowledge of non-timber forest products can be augmented through ICT. The success behind eToro arguably rests on two factors. The first factor was its ability to successfully draw in the youth of Long Lamai through the incentive of using modern technology in a novel way. The second factor was that eToro operates within the community's protocols governing traditional knowledge (Zaman et al. 2013). This is all the more important given the possibility of third parties exploiting of indigenous botanical knowledge. Lastly, eToro has encouraged the community to explore ways in which their indigenous botanical knowledge can lead to socio-economic benefits.

CONCLUSION

Indigenous communities face the twin challenges of balancing outside influences with the consolidation of traditional organisational structure and culture, and a limited set of economic activities due to the disadvantage of economic distance. This contributes to their status as some of the most marginalised communities in the developing world. Our case studies of the Maasai community of Terrat in Tanzania, the Kelabit of Bario and the Penan of Long Lamai, both in Sarawak, Malaysia, show how information and communications technologies can go some way to addressing these twin challenges.

In Terrat, the community radio station Orkonerei Radio Station FM directly impacted the Maasai community by consolidating the Maasai identity, improving health, education and income levels, and through facilitating improved governance and political participation. Indirectly, the community radio station led to the introduction of renewable electricity in Terrat and the establishment of dairy processing facilities and small businesses. In Bario, the eBario telecentre increased connectivity by improving communication with relatives in urban areas and reducing the transaction costs associated with tourism. Meanwhile, the eToro project in Long Lamai has helped catalogue and pass-on the Penan's traditional botanical knowledge to the next generation. Furthermore, eToro has encouraged the community to explore how their indigenous botanical knowledge can contribute to tourism and non-timber forest product commercialisation – two economic activities that can result in socio-economic benefits for the Penan community.

The three examples, however, caution us from seeing ICT as a silver bullet for indigenous communities. Specifically, we see the continued importance of physical infrastructure, financial sustainability and market development. Starting with physical infrastructure, both the Orkonerei Radio Station FM in Terrat and the eBario telecentre in Bario were constrained by

the high price of diesel in order to generate the necessary electricity required. In both cases, novel decentralised generation technologies were implemented through partnerships with external actors to address this. In the case of Bario, however, the innovative solar-diesel hybrid system continued to struggle to power the telecentre due to the climate in the Kelabit Highlands.

Both the community radio station in Terrat and the telecentre in Bario have found it difficult to be financially sustainable when external support was scaled back. This is not uncommon in the ICT for development literature and is usually attributed to a top-down approach that was supply-led and not demand-driven (Unwin 2009). The argument espoused by this view is that demand-driven ICT initiatives will be financially self-sufficient due to the willingness of community beneficiaries to pay for the service. The examples of Terrat and Bario, however, question this viewpoint and suggest that ICT initiatives such as community radio and telecentres exhibit many public good characteristics and, as a result, will struggle to be financially self-sufficient without external support.

Lastly, the case study of eToro shows us that although ICT can help raise awareness about new value-adding economic activities, acting on these activities will often require significant market development. For example, in the case of non-timber forest product commercialisation connecting producers and consumers is often difficult due to niche market demand, difficulty supplying a sufficient quantity of high quality products to meet demand due to the low density of production, yield variation due to climatic and ecological conditions, and the often rapid perishability of NTFPs. As a result, state and non-state institutions are often required to structure a supply chain to connect producers and consumers and an appropriate regulatory framework (Belcher et al. 2005; Wynberg and Laird 2007).

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SMART VILLAGES

New thinking for off-grid communities worldwide

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