CHAPTER 1

Energy, Infrastructure and the MDGs

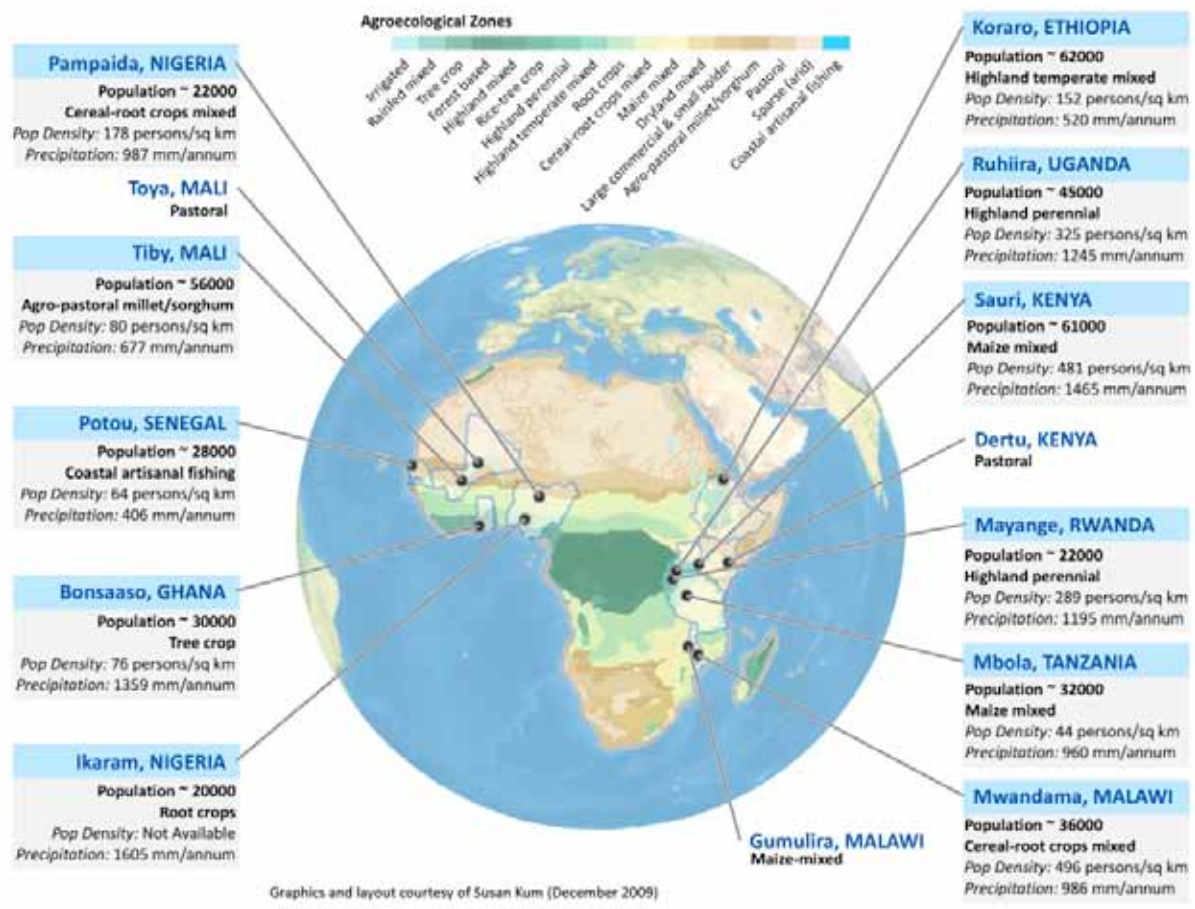
The Millennium Development Goals (MDGs) and the Millennium Village Project (MVP)

At the United Nations Millennium Summit in September, 2000, world leaders placed development and poverty eradication at the heart of the global agenda by adopting the Millennium Declaration. This led to the Millennium Development Goals (MDGs): concrete, time-bound objectives for dramatically reducing extreme poverty in its many dimensions by 2015 —income poverty, hunger, disease, lack of infrastructure and shelter—while promoting gender equality, education, health, and environmental sustainability. Soon after, UN Secretary General Koffi Annan tasked the UN Millennium Project, a research body led by economist Jeffrey Sachs under the auspices of the UNDP, to propose a practical path, with budgets and timelines, for the world to achieve the MDGs by 2015. The Millennium Project's conclusion, outlined in a series of sector-specific documents, was that the world has at its disposal the knowledge, tools and resources to achieve the goals under existing international commitments made at the Millennium Summit, the Monterrey Conference on Financing for Development, and the World Summit on Sustainable Development in Johannesburg[1].

Then as now, despite many challenges facing various parts of the world, Sub-Saharan Africa—with its many small, land-locked countries and weak transportation and communications infrastructure—is, in many ways, the epicenter of the global poverty crisis. It has the planet's lowest rates of electricity access, a singularly high disease burden and hundreds of millions living below the poverty line. Thus, the Millennium Villages Project (MVP) was initiated in Africa—in the village of Bar Sauri, in western Kenya, in 2004—as a practical effort to demonstrate that the goals could be achieved in this quantitative and time-bound fashion, and to test the cost predictions of the Millennium Project, and investigate the best existing and most novel technical and operational approaches to support this goal. The project expanded to include 14 village "clusters," in 10 countries, throughout all major agro-ecologies spanning Sub-Saharan Africa. The villages comprised a total population of around 500,000, all residing in "hunger hotspots".

From the beginning, the project was intended as an integrated, multi-sectoral effort. The challenge for the infrastructure investments was to cost-effectively address all critical bottlenecks. Teams in each site follow a common framework of MDG-related objectives in a range of sectors, including agriculture, health, education, environment and infrastructure. These broad goals are adapted to local conditions and become site-specific targets. This report describes the efforts related to building construction, energy, roads, ICT and piped drinking water where such systems have been deployed. Smaller-scale water interventions and activities related to landscape restoration for water management and storage were part of the agriculture and environment focus.

Figure 1.1: Millennium Village Project (MVP) Sites, by agroecological zone: 14 locations in 10 countries.



INFRASTRUCTURE AND THE MDGS

The MDGs themselves are expressed primarily in terms of outcomes for human health and welfare, and rarely mention infrastructure[2]. However, investments in energy, roads and transportation, ICT and water infrastructure are important enab lers of communities and nations in achieving the Goals.

ENERGY

Improved energy services are necessary for meeting almost all the Goals. Electricity is critical to providing basic social services, including health and education. Reliable energy in clinics enables sterilization, access to clean water, and the refrigeration of essential medicines. Power in schools supports instruction, administration and teacher retention. The lack of electricity that is common to poor, rural areas can act as a disincentive for skilled workers to stay, further limiting local economic development.

Household energy services—including lighting, cellphone charging, and basic media, such as radios –are a substantial part of household budgets for poor families. Lighting from kerosene wick lamps and disposable batteries can be twice as costly on a per unit basis as light from solar rechargeable lanterns, and at least

1. The Earth Insitute, Millennium Promise, UNDP. Millennium Villages. http://millenniumvillages.org/ (accessed June 2011).
2. UNDP. The Millennium Development Goals. 2011. http://www.beta.undp.org/undp/en/home/mdgoverview.html (accessed June 2011).

ten times as expensive as light powered by a central electricity grid. Cooking with fuelwood and crop residues has been associated with a significantly higher disease burden due to indoor air pollution, and means added time and labor spent on fuel collection by women and children. Greater efficiency of cooking fuels and technologies, combined with programs to enhance local biomass fuel availability, can reduce these burdens, freeing up time for education and income-generating work, and lessening pressure on fragile ecosystems.

Machinery powered by electricity, fossil fuels, or renewable energy (water, wind) can support income-generating opportunities such as irrigation, agricultural processing and light manufacturing. Productive uses of mechanical power, especially those that benefit women, can provide social and economic benefits.

ROADS AND TRANSPORTATION

Transport networks and services are critical to economic growth and the efficient delivery of essential social and health services. High transportation costs affect the rural poor severely through adverse impacts on farm incomes. Farmers in remote areas receive less for their products at the farm gate, simply because it is costly for buyers to reach them. Poor transport also limits market access—and thus bargaining power. Finally, poor transport raises the risks of damage and spoilage while transporting crops. Those without access to good transportation pay higher prices for inputs, because it is more difficult to get to them. The poor typically travel further—over more difficult roads—for essential services. Motorized transportation depends on the density and quality of road networks; the cost and availability of fuel, vehicles, maintenance and repair; and the risk of accidents, which is higher where roads are poor. All of these factors tend to be unfavorable in poor areas, thus transportation costs can easily be higher for rural Africans than for residents of developed countries.

ICT

Most people in rural Africa now have access to a mobile phone. Being "connected," by voice and increasingly with data services, is transforming the lives of the poor. Until recently, access to ICT other than radio was achieved only rarely due to the expense of connectivity, hardware, energy and maintenance. Mobile phones allow people to connect instantaneously over long distances. This allows a farmer to quickly access crop prices in distant markets and represents a lifeline for a woman who needs to call for help. Mobile phones also provide a platform for improved service delivery in agriculture and health. Community health care workers (CHWs), armed with basic mobile phones, can register the children they care for by simple SMS. Mobile phone based payment systems promote savings and have allowed for innovative new financial services tailored to the poor, such as micropayments for electricity over mobile phone enabled microgrid systems. Mobile phones will become more critical as they become increasingly integrated into the delivery of vital services for the rural poor.

WATER AND SANITATION

Infrastructure plays an important role in ensuring that clean water-- fundamental to human health and welfare—can be obtained from improved sources such as boreholes and protected springs, then stored, transported and delivered in a manner that is efficient, reduces household labor, and ensures that it remains clean. Sanitation, through interventions such as clinic incinerators and improved latrines, plays an important role in preventing infectious diseases.

Infrastructure at the Start of the Millennium Village Project

The scarcity and generally poor condition of infrastructure in the MVs at the start of this project in 2005-06 was representative of rural Sub-Saharan Africa (SSA) and other areas of extreme poverty. Market centers, social infrastructure (health and education

Table 1.1: Linkages Between Infrastructure and the MDGs

Infrastructure Sector	1: Poverty & Hunger	2: Primary Education	3: Gender Equality & Women's Empowerment	4, 5, 6: Health	7: Environmental Sustainability
MDG					
Energy	Modern energy services increase productivity of human labor, while enabling enterprise development & income Energy can raise productivity and help reduce post-harvest losses More efficient energy use (cooking, lighting) reduces expenditures on less efficient energy resources Improved cooking can reduce fuel and related labor demands	Electricity and lighting enables studying and educational tools and services in schools (computers, projectors, etc) and promotes teacher retention More efficient cooking can reduce time spent fetching wood	Improved cooking can reduce time/labor burden and reduce indoor air pollution Street lighting improves women's safety	Permits cold chain for vaccines, reagents, sterilization, operation of essential laboratory equipment and operating theaters Modern energy can be safer Electricity enables pumped clean water and purification Increases hours of facility operation / nighttime services Helps retain qualified staff	Efficient cooking and switch to modern fuels (LPG) can reduce demand for charcoal or other biomass sources reducing pressure on local ecosystems from fuel collection More efficient agriculture (including fertilizer, mechanization) can reduce need for additional land clearing Improved cooking can reduce greenhouse gas emissions and black carbon
Transport	Facilitates market access and reduces costs of trade, inputs prices , and monopoly power of agricultural middlemen Reduces social / family travel costs	Can improve students' access to school, reducing drop-our rates, particularly for girls	Reduces time and transport burden and eases independent movement for women Can save time, and increase access of women to health services	Increases access to health facilities Reduces emergency response times Improved roads can be safer for drivers and pedestrians	Improved public transport services reduces overall environmental impact
ICT	Increases access to weather, market and income-related information Enables extension, outreach and other training for increased incomes (agriculture, business)	Enables distance learning, access to educational media and communications Aids in teacher retention Improves record-keeping and school management	Reduces isolation of working in home, enables education at home Enables emergency communication and reporting of violence	Increases access to emergency care Supports improved medical information systems (ChildCount), 'distance medicine', and access to health education media Improves access to and quality of public and community health systems	Improves natural resource information gathering, mapping and monitoring
Water and Sanitation	Irrigation (combining improved water access and energy) can dramatically raise agricultural productivity	Rainwater harvesting can reduce water gathering labor for schools by children Reduced water-borne disease, improves school attendance	Improved/piped water sources or systems reduces women's time/labor burden of fetching water	Clean water is essential for health services Cleaner drinking water reduces water-borne diseases Safe disposal of medical waste prevents spread of disease	Increased availability of water and sanitation can improve local environments

facilities) and households frequently had little or no access to "network" infrastructure (electric grids, piped water and all-weather roads) or mobile telephony, for which voice coverage was spotty and data service non-existent. The sites lacked affordable, reliable stand-alone power and water systems. The poor paid a premium for low quality services to meet their basic needs: Rural households paid the equivalent of $10 per kWh of electricity for low quality lighting from kerosene or disposable cells; cooks used inefficient, traditional three-stone fires; poor farmers paid nearly 50 cents to transport one ton of produce one kilometer, nearly three times the average rate of rural India.

- **Institutions:** The number and capacity (size and services delivered) of schools and clinics was inadequate for the population they served. Most of those lacked drinking water, sanitation services and reliable electricity. Grid connections were extremely rare, and off-grid power sources— such as solar photovoltaic or diesel generators—were improperly sized and poorly maintained. Essential needs such as nighttime lighting, vaccine cold-chain storage and clean water in clinics went unmet or required costly substitutes. Record keeping was almost entirely on paper, making data difficult to collect and drastically limiting its use and reporting throughout health, education and other government systems. Although institutions were usually located near all-weather roads, there were often seasonal blockages, especially in heavy rains. Schools that served meals used inefficient three-stone fires, often relying on schoolchildren to collect fuelwood.

- **Market centers and businesses:** Most lacked grid electricity, raising basic service costs and preventing other income-generating activities such as refrigeration, television, carpentry and welding. Many markets lacked mobile phone network coverage, and none had Internet service. Mobile phones and vehicle batteries were recharged using expensive diesel gensets, and most grinding was done at market diesel mills. Access to paved road and transport services varied widely.

- **Households and smallholder farms:** Even in communities served by a central electricity grid, household connections were virtually nonexistent. Cooking was generally done on three-stone fires using collected biomass, while lighting was via kerosene wick lamps. Small electrical appliances (radios, flashlights) were powered by disposable batteries. Mobile phone ownership was rare, and phones were often left unused due to the high cost of power and the lack of network coverage. Less than one-third of the population lived within two kilometers of an all-weather road. Piped water and irrigation systems were rare.

Such are the infrastructure challenges of rural sub-Saharan Africa, due to poverty and low population density. The high cost of project implementation relative to the populations can prohibit investment by governments, donors, and the private sector. In addition, thin value chains for technologies—with few vendors and post-sales support—result in the perception that systems are unreliable. Yet overcoming energy, transportation, and communication challenges are crucial to progress.

The Strategy for Improving Infrastructure

The broad objective of the MVP infrastructure program is to reduce by half the number of people without access to modern energy, transportation, communication services and water and sanitation by 2015. Access is defined as a presence in the household or the community, meaning within two kilometers. The targets and strategies to achieve them vary:

- Energy interventions focus on electric grid extension, increased access to off-grid electricity, mechanical power and improved energy for cooking. A key objective has been to support and collaborate with governments and utilities to extend the electric grid "backbone" to more than 50% of a cluster's villages, providing power to markets and social infrastructure (schools, clinics, and government offices). In some

MVs, household connections are being promoted by limiting connection costs to $50, with the help of loans or installment plans. Where grid extension is not feasible, SharedSolar micro-grids (small systems serving 10–20 households) have been installed, and the project has invested in commercial supply chains for portable, rechargeable light emitting diode (LED) lanterns, which can also charge mobile phones. The project has supported the testing and introduction of efficient improved cookstoves by directly investing in large stoves for schools and establishing commercial supply chains for smaller household models.

- MVP aims to improve access to transportation, and to ensure that at least half of the community is within two kilometers of an all-weather road. It supports spot improvements, including installing culverts at water crossings and grading and surfacing dangerous slopes, with a focus on rehabilitating main village roads that connect the MVs to national networks. The MVP collaborates with governments, while engaging community members for improvements and maintenance. The MVP also implements community-managed transportation services, such as a community truck, emergency vehicles, and other vehicles for market transport. The MVP uses a model that manages the recurring costs, repairs and reinvestments of revenue arising from community-managed transport, with communities benefitting from and contributing to increased access.

- In ICT, the MVP supports access to mobile phone networks within two kilometers of 80 percent of households and basic data connectivity to key institutions (schools, clinics, and ICT kiosks) while introducing mobile phone-based health services. These objectives have been facilitated by partnerships with regional network operators, which have helped to expand and strengthen GSM network coverage. The MVP also aims to increase access to computers and the Internet in schools and communities, for instance, through the purchase of low-power and other technology innovations such as ChildCount (see Chapter 5).

The budget for the above interventions was $11 per capita per year ($5 for Energy, $5 for Transport, and $1 for ICT). This means that a cluster of villages with a population of 5,000 had an "infrastructure" budget covering these three categories of interventions of $55,000 per year, or $275,000 for the entire five-year project.

- MDG-related water and sanitation projects—improved drinking water access and irrigation—are administered in a site-specific manner. At some, a donation of piping has made possible piped water systems that supply clean water from boreholes to community taps. Most sites have programs to improve drinking water access by protecting springs from contamination. Irrigation programs have focused largely on the market-based provision of small diesel pumps that farmers can rent or buy, thereby contributing to a revolving fund for the future purchase of more pumps. The sanitation interventions have involved establishing incinerators at health facilities and improved latrines, primarily at schools.

The water activities were separately budgeted at $3.75 (roughly $4) per capita per year, or $18,750 per year for a village of 5,000. Over five years, the total water and sanitation budget for this population would be $93,750 (roughly $100,000). ■