Material Flow Management in anti-poverty sustainable development activities:

A Case study from Siem Reap, Cambodia

By Christine E. Meister

51209616

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Certification Page

This report presented to Ritsumeikan Asia Pacific University is an original work. It draws on work and reports done by institutions and authors, all of whom have been cited appropriately in the body of the report to the best of my ability and knowledge. The authors and institutions whose work was cited have been explicitly detailed in the reference section.

Christine Meister
Beppu, Japan
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List of Acronyms

ADB	Asian Development Bank
ASEAN	Association of South East Asian Nations
BAU	Business as Usual
CMDG	Cambodian Millennium Development Goal
CO_2	Carbon Dioxide
CTO	Community Translation Organization
FFW	Food for Work
GDP	Gross Domestic Product
GE	Green Economy
GHG	Greenhouse Gas
GW	Global Warming
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
Ha	Hectare
HT	Human Translation
IRRI	International Rice Research Institute
KR	Khmer Rouge
kWh	Kilowatt Hour
LPG	Liquid Petroleum Gas
MDG	Millennium Development Goal (global)
MFA	Material Flow Analysis
MFM	Material Flow Management
Mm^3	Million cubic metres
NGO	Non-governmental Organisation
NSDP	National Strategic Development Plan
PEI	Poverty-Environment Initiative
PPP	Public Private Partnership
REN	Renewable Energy
RGC	Royal Government of Cambodia
SD	Sustainable Development
SODIS	Solar Disinfection
STI	Swiss Tropical Institute
UN	United Nations
UNCDF	United Nations Capital Development Fund

UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNU	United Nations University
USD	United States Dollar
UXO	Unexploded Ordnance
WB	World Bank
WFP	World Food Program
WHO	World Health Organization
ZE	Zero-Emissions

Executive Summary

Material Flow Management (MFM) is a useful tool for improving the systems of regions in order to achieve higher efficiency of economic activities, resource use, and value added for social well-being. This paper explores the extent to which it can be used in impoverished rural regions of the developing world. In particular, it examines a case study of the Trav Kod reservoir and irrigation system reconstruction implemented by the Human Translation/Community Translation Organisation in Ballangk commune, Prasath Bakong, Siem Reap, Cambodia. The paper is intended as a background to what could potentially be a larger, more quantitative work. It explores current literature on sustainable development for impoverished countries in general, and for Cambodia specifically, in particular pointing out the linkages between poverty and environmental degradation. It then provides background on the steps of Material Flow Management and Zero-Emissions methodology. Then, it examines the sustainability of the Trav Kod reservoir project in terms of its effects on the economic, social and environmental well-being of the region, and the ability of the new system to continue itself. It then explores the extent to which the implementing organisation used MFM-style steps to complete the project, and what can be learnt from their experience; i.e. what steps should be taken into special consideration, and what should be done differently. It then explores possible implications for further research.

In the case of Ballangk, the need for irrigation to improve food security was rather obvious and was rightly dealt with first as a kind of "catalyst project." In the area of financing, the moneymaking potential in the eyes of the kind of investors MFM implementers usually deal with is not so immediately obvious, and therefore project plans should be made with the goals of major international donors in mind. Therefore, the paper finds that, in regions such as Ballangk, poverty-environment linkages need special consideration in the material flow analysis of the area concerned in order to find the greatest potential that could attract international donor dollars. The most important consideration, however, is in stakeholder management: Community Translation was able to gain the trust of the beneficiaries, and the stakeholder management aspect of MFM is especially useful in using this methodology in impoverished rural regions.

1. Introduction

Poverty, food insecurity, and lack of access to modern infrastructure are pressing problems for much of the world's population. While progress has been made, there is still much to be done in terms of building greener economies, alleviating poverty, and achieving the United Nations Millennium Development Goals. Environmental destruction still runs rampant--sometimes in the name of "development," other times for the sake of simply getting by.

Material Flow Management purports that environmental and social problems are a consequence of the poor management of systems. Although these systems are in the process of being built, those in the developing world are no exception. A new field, Material Flow Management (MFM) has gained a reach mainly in small to medium enterprises in the developed world, and in the so-called "emerging economies" of places such as China, Turkey, and Brazil. The focus of this paper is the potential use of MFM as an anti-poverty mechanism in the poorest, most marginalised regions of the world.

This research is meant to be background research to a larger work. It draws on current literature from major development organisations, and follows the activities of Human Translation/Community Translation Organisation, a fledgling Cambodian and American-run nongovernmental organisation and their flagship project: the Trav Kod reservoir and irrigation system restoration in Ballangk Commune, Prasath Bakong district, Siem Reap province, Cambodia. It was written with the following questions in mind: What are the trends and goals for sustainable development activities? In what ways can MFM projects help regions achieve these goals? Given the trends

stated in the current literature, in what ways does the Trav Kod project add value to the region, and in what ways can it be considered MFM? What should the next steps be for Community Translation, and how can MFM help? What are the potential implications for MFM in Cambodia as a whole?

The paper will first give a general picture of the potentials and challenges for Cambodia. Then, it will review current literature on sustainable development and green economy from major authorities such as UNEP, UNDP, the World Bank, the Asian Development Bank, and the Royal Government of Cambodia. It will provide background on the goals and methods of MFM, comparing these goals with those of the said authorities to provide insight on what MFM could potentially do in Cambodia. Then, it will move to the case study of CTO's Trav Kod project, exploring the ways the project has added value to the community, and highlighting potential areas of concern for the future. After that, the paper will discuss the ways MFM could be used to further improve the project, what steps in the usual MFM process have to be modified, and the implications for using MFM in similar areas.

During the author's time with CTO in Cambodia, it became apparent that the NPO is looking for ways to develop itself as an organization and be able to continue operating. While MFM could potentially help it transition to a social business model rather than that of a donor-dependent entity, this paper will primarily stay within the subject of the project itself rather than the operation of an NGO or NPO. As with most projects in the developing world, this one is hindered by a lack of data, time constraints and language barriers. For that reason, the paper is very qualitative, however, it was meant

from the outset to be background theory for a more data-intensive applied research project. Additionally, corruption is a factor that needs to be considered in Cambodia, especially in terms of stakeholder management. However, it takes years of being "inside" a certain governmental system to understand its patterns of corruption, and people who are inside are understandably reticent about discussing the subject. Therefore, this topic will go largely unaddressed in this paper. Finally, while there is great potential for ecotourism-based local economies in Cambodia and Ballangk itself, this paper will mostly stay with the immediate needs of the people of the commune, and will keep ecotourism in mind as a potential project for the future.

2. Cambodia: Background, Issues and Potential

This section will provide background on the Kingdom of Cambodia as a whole. It will give basic population and economic figures, pressing environmental issues, poverty indicators, and implications for dealings with stakeholders in the country based on its recent history. It will make mention of the political situation of the last few decades. While this paper is not meant to be a historical account of the country, it is necessary for better understanding how to deal with the local people involved in any project.

2.1 Background on Cambodia

Fig. 1: Cambodia

Cambodia is located in Southeast Asia between Viet Nam, Thailand and Laos, bordering the Gulf of Thailand. Its total area is 181,035 sq km, 176,515 sq km of which is land (20.44% of it is arable), 4,520 sq km of which is water. The climate is tropical and rainy, with a monsoon season from May to November; the dry season is from December to April, and there is little seasonal temperature variation. Natural resources include oil and gas, timber, gemstones, iron ore, manganese, phosphates, and hydropower potential (United States Central Intelligence Agency, 2011). Overall, the country is considered to be water-rich, but suffers from droughts and intermittent rainfall; a case of

either too much or too little (United Nations Capital Development Fund, 2010).

2.2 Environmental Issues

Cambodia is highly vulnerable to climate change. This is due to its weak infrastructure, largely agrarian economy, and low elevation of the central plain. The country also experienced heavy deforestation during the 1990s due to poor regulations on logging. A moratorium on logging was imposed in 2002, but forest cover still declined from 61% to 59% between 2002 and 2006 (United Nations Capital Development Fund, 2010). There are still illegal logging activities throughout the country, as well as strip mining for gems, and these activities have resulted in mangrove swamp destruction which threatens natural fisheries (United States Central Intelligence Agency, 2011), as does illegal overfishing. This in turn threatens the country's food security (United Nations Capital Development Fund, 2010). Still, the Tonle Sap region enjoys one of the largest freshwater fish catches in the world (ibid.).

Rural energy demand is projected to rise in the coming decades. The ADB (2009) provides a BAU scenario in the chart below, increasing the use of current sources of energy such as charcoal, firewood, LPG, candles, etc. For households that can afford it, diesel-powered generators or battery charging stations are used for power needs at a premium price.

Table 1. Current and Projected Energy Demand for Cambodia

Demand	2007	2010	2012	2015	2017	2020	2022	2025	2027	2030
Electricity (GWh)	750	932	1,098	1,217	1,296	1,472	1,613	1,887	2,026	2,222
Total charcoal (000 t)	321	424	535	801	807	770	756	729	719	724
Total firewood (000 t)	4,696	4,013	3,400	2,236	2,099	1,993	1,880	1,508	1,286	973
Total Liquefied petroleum gas (000 t)	61	77	83	96	110	147	180	232	255	283
Total kerosene (000 t)	329	336	351	388	417	451	457	501	535	589
Total candles (t)	626	688	740	822	885	987	1,067	1,186	1,276	1,410
Total animal dung (000 t)	25	28	28	27	28	29	29	30	31	32

GWh = gigawatt-hour; t = ton.

Note: The forecast excluded energy use for transportation.

Source: United Nations Development Programme. 2007.

Energy costs in Cambodia are already higher than those of its neighbours, as shown in the following table. With availability of charcoal and firewood decreasing along with forest cover, and rising prices of petroleum products, any increase in purchasing power resulting from increased agricultural income is likely to be offset as rural Cambodian households struggle to keep up with these costs.

Table 2. Electricity Tariffs in ASEAN Countries in 2004, in US cents/kWh (Williamson, year unknown)

Country	Residential	Commercial	Industrial
Brunei Darussalam	2.88-14.42	2.88-11.54	2.88-11.54
Cambodia	9.17-17.03	15.72-17.03	12.58-15.72
Indonesia	1.69-4.60	2.77-5.65	1.71-4.38
Lao PDR	0.55-3.8	4.18-5.22	3.51
Malaysia	5.53-8.94	2.63-10.52	2.63-10.52
Myanmar	8.14	8.14	8.14
Philippines	3.15-10.71	3.68-9.85	3.35-10.84
Singapore	9.23	4.42-7.18	4.16-6.69
Thailand	3.41-7.47	2.94-7.47	2.94-7.13
Vietnam	2.92-8.17	4.24-13.96	2.83-13.96

However, there is untapped REN potential for the country, and the high cost of conventional energy sources makes exploiting REN more feasible than in places with cheap fossil fuel sources. Potential sources include hydropower in the Mekong valley, biomass, wind, and solar power. Solar photovoltaic systems in Cambodia currently

produce 200−250 kilowatt peak, with telephone repeater stations accounting for more than 80% of the installed systems. Small wind turbines were attempted on the Tonle Sap lake, the southern coast near Sihanoukville and in the southern mountain region, but the project experienced technical failures. Biofuel from the *Jatropha curacas* plant is a potential source as well, as the plant is well-suited to conditions in Cambodia .

Table 3. Potential for Renewable Energy in Cambodia (ADB 2009)

Energy Sources	Potential (GWh/year)	Current Installed Capacity (GWh/year)	Remaining (GWh/year)	Potential Annual GHG Abatement (kton CO_2 equivalent)
Hydropower	37,668	55	37,613	26,228
Biomass	18,852	0	18,852	13,146
Solar	65	1	64	44
Wind	3,665	0	3,665	2,556

CO2 = carbon dioxide, GHG = greenhouse gas, GWh/year = gigawatt-hour per year, kton = kiloton.

2.3 Economic Issues and Potential

From 2004 to 2007, the economy grew about 10% per year, driven largely by an expansion in the garment sector, construction, agriculture, and tourism. GDP contracted 1.5% in 2009 as a result of the global economic slowdown, but climbed more than 4% in 1010, driven by renewed exports (United States Central Intelligence Agency, 2011). The proportion of the population living in poverty fell from around 47% in 1993 / 94 to an estimated 30% in 2007. However, much of the benefit of Cambodia's growing economy went to the already better off; Poverty trends across Cambodian regions are related to GDP growth, but with some anomalies: GDP is performance is often based on activities − e.g. tourism in Siem Reap or natural resource exploitation in the cases of Mondulkiri − that do not necessarily spread wealth broadly amongst the population (United Nations Capital Development Fund, 2010). Therefore, we must examine other indicators such as achievement of the MDGs in order to examine Cambodia's progress.

One of the main drivers for Cambodia's economic growth is tourism. The number of foreign visitors to Cambodia has exploded, from 118,183 in 1993 to 2,161,577 in 2009. In 2009, tourism brought in about 1.6 billion USD (Royal Government of Cambodia, 2010). The country's total GDP in 2010 was 11.3 billion USD, giving tourism approximately 14% of the country's GDP. Angkor Wat, located in Siem Reap province, is by far the most popular attraction for tourists.

Two thousand seven hundred square kilometres of land are irrigated; 98% of the country's domestic water consumption is for agriculture (United States Central Intelligence Agency, 2011). As of 2000, water consumption was 290 cubic metres per capita (ibid.), but increasing tourism is putting a tremendous amount of stress on the water table around the Angkor complex. Tourism to Angkor Wat has proven to be a mixed blessing for Siem Reap. It has brought throngs of tourists putting cash into the local region, but has resulted in a daily assault on the sandstone monuments, and increasing water demand from the hotels and guest houses is causing the aquifer to sink. This is resulting in the monuments of Angkor to sink as well (Independent, 2008). Given the importance of Angkor in tourism revenues and the national psyche as a whole, the consequences of a dropping water table could be catastrophic. However, as mentioned before, Cambodia is considered to be a water-rich country. As enough rain falls during the wet season to flood the cities, using groundwater to meet water needs during the year seems illogical from a MFM standpoint. Therefore, this represents opportunity to use rainwater catchment to mitigate this problem.

2.4 Factors affecting Stakeholder Management

One cannot speak of Cambodia's recent history without mentioning the reign of the Khmer Rouge. It was during this time that the country's infrastructure, manpower, knowledge, and lives were decimated with systematic cruelty. The KR lived on in rural areas well into the 1990s, and the scars of the regime are still real in the minds of the people. This has given many people a certain "survival mentality" which, while effective in a time of war, is not conducive to the formulation of sound, future-oriented plans for regions. According to the people leading CTO, this mentality has made the populace, especially the older members of communities who still clearly remember the regime, highly risk-averse and even less receptive to new ideas than usual. Even before the coming of the KR, the nature of the monsoon season that allows for so little during dry times led Cambodian farmers to be very risk-averse (Ya, pers. communication 2010). It may be tempting to simply bypass the crucial step of stakeholder inclusion in order to get faster results as development deadlines loom. However, it will be demonstrated further in this paper that, with extra patience and stakeholder care, the resulting cooperation will yield better results in the long term.

3. Definitions and Literature Review

In order to answer the larger research question of the role of MFM in SD-oriented poverty alleviation projects, the terms “poverty,” “sustainable development,” “poverty alleviation,” and "green economy" should be defined in order to state the theoretical context. This section will review existing definitions of those things, provide a theoretical context and review of current literature regarding sustainable development, and the concepts discussed will then be used as the framework for finding the place of MFM in poverty alleviation and Cambodia's sustainable development later in the paper.

3.1 Definitions

Poverty is a somewhat vague concept. The same vagueness applies to its sister terms such as “living standards,” “poverty line,” and “relative poverty.” The World Bank defines absolute poverty as “the inability to satisfy basic needs in terms of nutritional intake, shelter, basic amenities, and the ability to take advantage of opportunities such as education.” The “poverty line” is when a household’s “consumption falls under the level sufficient to maintain basic needs,” and relative poverty focuses on inequality across a population in terms the distribution of consumption, assets, education or any other welfare measure (World Bank 2006).

The accepted general definition of sustainable development (SD) is “development that meets the needs of the present generation without compromising the ability of later generations to meet their own needs,” and set out three pillars: economic, social, and ecological (Bruntland, 1987). In other words, it is a system that can function continuously without destroying itself on any of those three levels. “In a sustainable

development paradigm, the limitations of economic, societal and environmental resources are considered in order to contribute to present and future generations' welfare and can be applied on local, regional, national and international levels, based on political will" (Glavic & Lukman, 2007). This recognition of *physical limitation* is an important point to consider for any sustainability paradigm. There are various ideas on how to escape from poverty. The following sections will describe past thinking and why it is not effective enough, followed by trends in the future of fighting poverty.

3.2 Literature Review of Development Trends in Cambodia

In response to the UN MDGs, the RGC released its own set of Cambodian Millennium Development Goals (CMDGS). In summary, these are:

- To eradicate extreme poverty and hunger
- To achieve universal nine-year basic education
- Promote gender equality and empower women
- Reduce child mortality
- Improve maternal health
- Combat HIV/AIDS, malaria and other diseases
- Ensure environmental sustainability
- Forge a Global Partnership for Development
- De-Mining, UXO and Victim Assistance (Royal Government of Cambodia, 2009)

In particular regard to CMDG7, the following table shows the way the RGC has adopted the UN MDGs into their own set of indicators:

Table 4. UNMDGs and CMDGs (Royal Government of Cambodia 2009)

Global MDG7	Cambodia MDG7
Target 9: Integrate the principles of sustainable development into country policies and programs and reverse the loss of environmental resources	**Overall target 13**: Integrate the principles of sustainable development into country policies and programmes and reverse the loss of environmental resources
Indicator 25: Proportion of land area covered by forest	*Indicator 7.1: Forest coverage as a % of total area*
Indicator 26: Land area protected to maintain biological diversity	*Indicator 7.2: Surface of protected areas*
	Indicator 7.3: Surface of forest protected areas
	Indicator 7.4: Number of rangers in protected areas
	Indicator 7.5: Number of rangers in forest protected areas
	Indicator 7.6: Proportion of fishing lots released to local communities
	Indicator 7.7: Number of community-based fisheries
	Indicator 7.8: Surface of fish sanctuary
Indicator 27: GDP per unit of energy use (as proxy for energy efficiency)	*Indicator 7.9: Fuel wood dependency*
Indicator 28: Carbon dioxide emissions (per capita) [Plus two figures of global atmospheric pollution: ozone depletion and the accumulation of global warming gases]	
Target 10: Halve by 2015 the proportion of people without sustainable access to safe drinking water	**Overall target 14**: Halve by 2015 the proportion of people without sustainable access to safe drinking water
Indicator 29: Proportion of population with sustainable access to an improved water source	*Indicator 7.10: Proportion of rural population with access to safe water source*
	Indicator 7.11: Proportion of urban population with access to safe water source
Target 11: By 2020 to have achieved a significant improvement in the lives of at least 100 million slum dwellers	**Overall target 15**: Halve by 2015 the proportion of people without sustainable access to improved sanitation
Indicator 30: Proportion of people with access to improved sanitation	*Indicator 7.12: Proportion of rural population with access to improved sanitation*
	Indicator 7.13: Proportion of urban population with access to improved sanitation
Indicator 31: Proportion of people with access to secure tenure	**Overall target 16**: Increase the proportion of the population in both urban and rural areas with access to land security by 2015
	Indicator 7.14: Percentage of land parcels having titles in both urban and rural areas

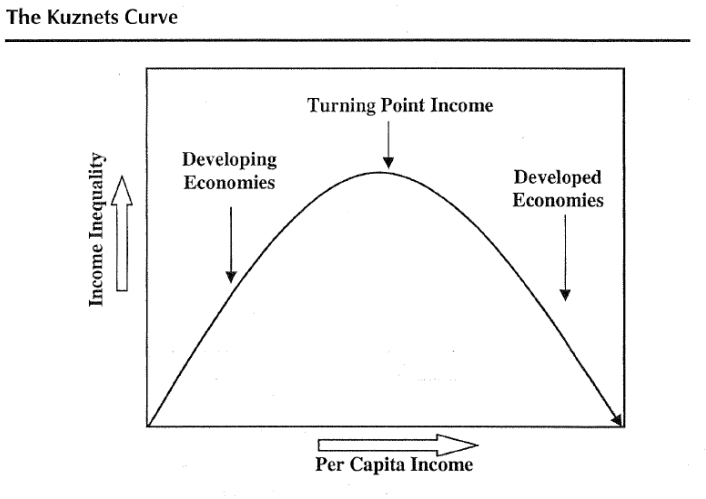
To fight poverty, the government of Cambodia has made environmental considerations a part of its official strategy. These indicators show ambitious targets in a variety of sectors. It is especially interesting to note the country's inclusion of UNMDG Target 9, which is to integrate sustainability concerns into overall policies and action plans. However, given the environmental stresses being experienced in the country, actual implementation of this bold statement leaves much to be desired. This is partly due to the local nature of problems in Cambodia, and regionalisation of authorities meant to deal with the problems (UN Capital Development Fund 2010).

The Kuznets Curve and Why GDP Growth Alone is not enough

To provide some theoretical context, this section will describe the Kuznets Curve and

the Environmental Kuznets Curve, and why these explanations for the usual path of development are not acceptable in today's world. The Kuznets Curve, purported by economist Simon Kuznets in the 1950s, described a phenomenon of development in which income disparity increases when countries first start to increase income, and then distribution becomes more equitable as income continues to increase (Yandle, Vijayaraghavan, & Bhattarai, 2002).

Figure 1. The Kuznets Curve

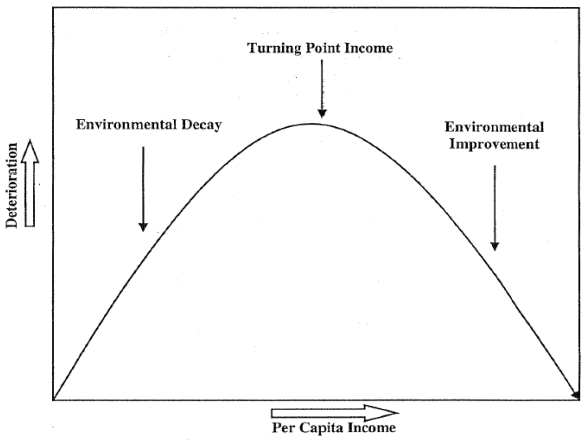


(Yandle, Vijayaraghavan, & Bhattarai, 2002)

After the publication of this idea, economists also began to study the relationship between national incomes and environmental degradation. While it had been previously believed that the quest for more material comfort and higher incomes inevitably led to more degradation, the new findings suggested otherwise. The new Environmental Kuznets Curve followed a similar inverted U shape, and implied that agrarian economies had low incomes but enjoyed pristine environmental conditions, industrialising ones had incomes that were increasing and environments that were deteriorating, while the final stage of development was that of the advanced, industrialised, "clean" economy. This cleanup was attributed to the transition to higher

levels of technology and a less material-intensive service economy, and more freedom to choose to spend this newly acquired income on cleaner air and water (Yandle, Vijayaraghavan, & Bhattarai, 2002).

Figure 2. The Environmental Kuznets Curve



According to Yandle,Vijayaraghavan and Bhattarai (2002), this theory stands in certain contexts, but there are several problems with this in practice. There is too much emphasis on a "clean" environment and not enough on material and energy usage, biodiversity, ecosystem services, and other less easily quantifiable aspects of a healthy environment. There simply are not enough resources in the world for all countries to attain the income standard necessary to reach the turning point in a business as usual scenario. In other words, sustainable development, in addition to the definition given by the Bruntland Commission as stated earlier, recognises the physical limits to the path that development has taken for the higher-income countries of the world as impossible for the rest of the world to follow. In this sense, the phenomena described by Kuznets cannot and does not apply.

If we were to play Devil's Advocate and subscribe to the Kuznets model in the case of Cambodia, agrarian communities such as the one that will be studied should lie along the "pristine" end of the curve, but even then there could be some immediate problems for the people living in the region. As incomes grow, degradation could theoretically increase if left to its own devices. For example, farmers could use this newly acquired income to buy more chemical fertilisers or pesticides, degrading the environment. This is a real practical consideration. However, it should not be taken as an overall theoretical context for thinking about rural poverty and development.

Another problem with waiting for incomes to rise is that the MDG deadlines are looming close, and the ones regarding sustainability are still not on track to meeting the goals. MDG 1 concerns income inequality, an issue with which Cambodia still struggles; the Gini coefficient assessing inequality has risen 0.04 between 2004 and 2007 (UN Capital Development Fund 2010). Additionally, many of the MDG indicators are not of a financial nature and will do little to contribute to GDP–but they represent great strides for the human development of people living in marginalised regions.

Cambodia is experiencing a steady growth in GDP. Between 1993 and 2002, growth was about 5.5%. Several data show the urban-rural divide. The population is 11.4 million, 85% of whom live in rural areas. Thirty-six per cent of the population lives under the national poverty line, and 90% of those under the line live in rural areas. While agriculture makes 70.7% of employment, it only comprises 33.4% of the nation's GDP. Furthermore, most of the gains made in recent years have gone to people

employed in industry and tourism (Royal Government of Cambodia, 2009). From this data, we can assume that it is the rural poor who are being left behind. However, while most of the gains have gone to those working in industry and tourism in urban areas, some gains have, in fact, reached the poor–just at a slower rate. According to the NSDP, "Even among the poor, a greater share of the people is now closer to the poverty line, indicating that the CMDG targets of reducing overall poverty level and food poverty level to 25 % and 13 % respectively in 2010and to 19.5 % and 10 % in 2015 are within reach *if specific actions are taken* starting with this NSDP" (Royal Government of Cambodia, 2006, emphasis added by author). This also implies the RGC's recognition that simple GDP per capita growth will not be enough to achieve the MDGs and CMDGs within the desired time frame without actions specifically targeted at the rural poor.

One way to specifically target the rural poor is geographically. Development progress in Cambodia is highly inequitable across geographical regions. The capital has made gains, but the provinces of the Tonle Sap region continue to struggle; regional differences will be discussed in a later section of this paper.

Another problem with the Kuznets Curve model of development and environmental protection for Cambodia is this notion of environmental quality as a luxury good. Environmental quality is not a "luxury good;" it is and will remain a necessity and a human right for people in agrarian communities. The UNEP/UNDP Poverty-Environment Initiative states that

> "natural resources such as forests and fisheries play a [large] role in the national incomes and wealth of less developed economies.

> Thus, a healthy and productive environment contributes significantly to human well-being and pro-poor economic development. Intact, functioning ecosystems provide services–such as the provision of food, water, fuel and fibre, as well as regulation of climate–on which people and nations rely on to earn income from fishing, forestry, tourism, and other activities" (UNDP & UNEP, 2009) .

Thus, any development which aims to help the poor must take care to preserve the environment on which their burgeoning economic and social systems depend, and proactively ensure value added to the regions, not exploit it in hopes that the resulting income increase will trickle down to them and give them the money required to "clean" it. Rather, SD should seek ways to jump over the "required" GDP per capita level for a vital environment. The following sections describe frameworks for achieving these goals that are already underway for impoverished regions.

Integrating Environmental protection and poverty alleviation

Institutions such as UNEP and the World Bank are realising that sacrificing environmental protection for GDP growth can actually be detrimental to the growth and progress of developing countries that are dependent on natural capital. This is the reasoning behind the UN's Poverty-Environment Initiative (PEI).
Poverty-environment mainstreaming is defined as "the iterative process of integrating poverty-environment linkages into policymaking, budgeting and implementation processes at national, sector, and sub-national levels. It is a multi-year, multi-stakeholder effort that entails working with government actors..., non-governmental actors..., and development actors" (UNDP & UNEP, 2009, p. 6). UNEP and UNDP recommend finding the linkages between conditions of poverty and

environmental degradation, and designing policies or projects around them. The following table shows general examples of poverty-environment linkages:

Table 5. Contribution of the Environment in Achieving the MDGs

Goal	Poverty-environment linkages
Poverty 1. Eradicate extreme poverty and hunger	• Livelihood strategies and food security of poor households typically depend directly on ecosystem health and productivity and the diversity of services they provide • Poor households often have insecure rights to land, water and natural resources, and inadequate access to information, markets and rights to participate in decisions that affect their resource access and use, thus limiting their capability to use environmental resources sustainably to improve their livelihoods and well-being • Vulnerability to environmental risks—such as floods, droughts and the impacts of climate change—undermines people's livelihood opportunities and coping strategies, thus limiting their ability to lift themselves out of poverty or avoid falling into poverty
Gender and education 2. Achieve universal primary education 3. Promote gender equality and empower women	• Environmental degradation contributes to an increased burden on women and children (especially girls) in terms of the time required to collect water and fuelwood, thus reducing the time they have available for education or income-generating activities • Including the environment within the primary school curriculum can influence the behaviour of young people and their parents, thereby supporting sustainable livelihoods • Women often have limited roles in decision-making, from the community level to national policymaking, which prevents their voices from being effectively heard, particularly with respect to their environmental concerns • Women often have unequal rights and insecure access to land and natural resources, limiting their opportunities and ability to access productive assets
Health 4. Reduce child mortality 5. Improve maternal health 6. Combat HIV/AIDS, malaria and major diseases	• Water- and sanitation-related diseases (such as diarrhoea) and acute respiratory infections (primarily from indoor air pollution) are two of the leading causes of under-five child mortality • Damage to women's health from indoor air pollution or from carrying heavy loads of water and fuelwood can make women less fit for childbirth and at greater risk of complications during pregnancy • Malaria, annual killer of an estimated 1 million children under age five, may be exacerbated as a result of deforestation, loss of biodiversity and poor water management • Up to a quarter of the burden of disease worldwide is linked to environmental factors—primarily polluted air and water, lack of sanitation and vector-borne diseases; measures to prevent damage to health from environmental causes are as important, and often more cost-effective, than treatment of the resulting illnesses • Environmental risks, such as natural disasters, floods, droughts and the effects of ongoing climate change, affect people's health and can be life threatening
Development partnership 8. Develop a global partnership for development	• Natural resources and sustainable environmental management contribute to economic development, public revenues, the creation of decent and productive work and poverty reduction • Developing countries, especially small island States, have special needs for development assistance, including increased capacity to adapt to climate change and to address other environmental challenges, such as water and waste management

Adapted from DFID et al 2002 and WHO 2008 in UNEP & UNDP 2009

The report mainly focuses on integrating poverty alleviation and environment in terms of setting out national policies rather than individual development projects. However, knowing that this is the general direction of current thinking on the subject can help those designing projects or looking for aid to ensure success.

The linkages between poverty and environment exist in Cambodia in a variety of ways. The World Bank uses the term "nexus" to describe the critical point between many factors influencing poverty, and identifies lack of sanitation as a major point in dragging the pace of human development, especially in rural areas. For example, lack of sanitation leads to frequent illness that hampers children's school attendance (World Bank 2009).

Green Economy and the Poverty-Environment Connection

What is meant by "green economy" is one in which economic growth and investments become less dependent on liquidating environmental assets and sacrificing environmental quality, and both rich and poor countries can attain more sustainable economic development. In other words, economic development today must ensure that future generations are left no worse off than current generations, and per capita welfare should not decrease over time (UNEP 2009). The 2009 Green Economy Report recognises several sectors and enabling conditions as important in building a green economy. Important sectors include forests, fisheries, water, energy, and tourism.

According to the report, the enabling conditions include strong environmental policies, proper resource pricing, investments into research and development, innovation rents, and aggressive environmental regulations that anticipate future scarcities (UNEP 2009). This is meant in very general terms. Therefore, it will be useful to look at Cambodia's efforts that are already underway, and how near or far the country is from attaining their

goals.

The RGC has its own ambitious plans for greening its economic development as well. Like the UNEP, UNDP and WB reports, it echoes the sentiment that the "develop now, clean up later" paradigm will not do in the long term. Its own special needs as a country for developing its green economy are based on access: to clean water and sanitation, renewable energy, information and knowledge, mobility, finance and investments, agricultural food security and non-chemical products, and sustainable land use. The RGC acknowledges that beneficiaries of much of the growth in the last decade has narrowed, and that this needs to change to achieve the "low carbon, socially inclusive" development a green economy should strive for. Threats to the green economy include population growth, and the impoverished status of many rural people that puts pressure on the environment, thereby creating a vicious cycle of poverty and environmental destruction as the natural capital of the rural poor's livelihood dwindles. However, that means that interventions from the government or NGO or PPP can and should protect both the environment and livelihoods (Royal Government of Cambodia, 2011)

Activities mentioned in the report that are especially relevant for the purposes of this paper include the management of ecological agriculture, natural resources such as water and renewable energy sources, and "eco-village" formation. These will be discussed in the next section, which will explore the possible role MFM could play in translating these ambitious plans into action for poor rural Cambodian villages.

Localisation of Development Authority

The literature regarding poverty and environment and green economy views implementation through the lens of national policy directives. However, Cambodia is a somewhat special case that calls for a more regionalised approach. The UNCDF's *Local Development Outlook 2010: Cambodia* paints a picture of a place of sharp intra-national divisions. It echoes the sentiment that, while the country has experienced growth, much of the benefit has gone to the already better-off segments of the population, and that growth is centred around the urban areas, leaving the rural areas out. The report also highlights the unsustainability of the country's economic growth. It is largely driven by foreign direct investment and supported by international development assistance, which is "vulnerable to external shocks." Furthermore, great untapped potential exists in the rural areas that have not received the benefits of the country's development. Although tourism, the garment industry, and construction have made the most gains in growth, agriculture is still the backbone of the Cambodian economy. Bringing irrigation to the 90% of Cambodian farms that do not have it in the dry season would increase yields and incomes for farmers dramatically. While the temple complex at Angkor has received the most tourist attention, there are temples from the same era in rural areas throughout the country, and they could potentially bring higher numbers and more sustainable tourism to the country. The forests and wetlands are home to threatened species of birds that could bring in more eco-tourism as well, helping to preserve the forests that otherwise would be marked for destruction.

In spite of these disparities, "Cambodia does not rely on an explicit National Policy to address territorial imbalances; local development... is closely linked with

de-centralisation and de-concentration reforms" (UNCDF 2010). In other words, the power and responsibility to develop local areas is in the hands of the commune councils. However, the actual ability of the councils to effect meaningful change has been limited by weak planning and little citizen involvement (ibid.). In sum, the rural areas possess great potential to strengthen the resilience of the economy as a whole through greater diversity, and the on-paper policy exists to empower the local areas. But there needs to be an implementation tool to bring about this change.

The purpose of the previous section was to explore the theoretical background, definitions, and current trends in sustainable development and poverty alleviation. While the paradigm of the past was to "develop first, clean up later" as we saw with the Kusnetz curve, there is widespread acknowledgement through the development community and governments that this is no longer a feasible course of action. Another point that is being recognised is that there is an inextricable link between poverty and environmental protection. Contrary to popular belief and common practice during the past few decades, destroying the environment for short-term gains will not help a country develop or bring people out of poverty; in fact environmental degradation destroys the source of livelihood on which the rural poor depend. The trend now is toward "green economies," and Cambodia has gotten on board with its own set of plans. However, actual implementation is of course, much more challenging, and requires a concrete methodology to make it happen.

4. MFM in Cambodia

This chapter will examine the way MFM can be used in the marginalised regions of the developing world, paying particularly close attention to the Cambodian case. The language used in MFM and ZE methodology suggests an audience geared more towards industrial management than in NGO-based development projects. Therefore, this section will attempt to show the connections and similarities between what is being called for by major development institutions in environmental protection and poverty alleviation initiatives. It will begin with an overview of the MFM and Zero Emissions Methodology as outlined by the UNU Tokyo. Next, it will point out issues it can help with in Cambodia and the developing world in general, paying particular attention to the principles of poverty-environment mainstreaming and green economy building as outlined in the previous chapter. Finally, it will outline some possible challenges or limitations to using MFM in this context.

4.1 Material Flow Management and Zero-Emissions Methodology

The following section will provide an overview of the methodologies of Material Flow Management and Zero-Emissions methodology. It will draw heavily on information provided by the German Federal Ministry for Environment, Nature Conservation and Nuclear Safety for MFM (IfaS & BMU, 2009), and the United Nations University Tokyo (Yamaji K, year unknown) for their contribution to the Zero Emissions framework.

What is Material Flow Management?

Material flow Management is, as the name suggests, first and foremost a management approach. It employs a holistic, regional perspective, taking account of all stakeholders−including companies, households, the public sector, the agricultural and

forestry sectors, etc.−to capitalise on all available synergies and options. The idea is to close material and energy cycles completely, reducing the need for expensive imports of fuel and other products that create little relevant value in the region (IfaS & BMU, 2009). The aims of MFM include keeping money within the system, creating jobs, reducing emissions, strengthen local economies through networking, increase system efficiency while decreasing operation costs, creating stakeholder networks, activating regional potential, supporting innovative small/medium enterprises, and enhancing regional added value.

The major steps of MFM are as follows:

1.) Material flow analysis
2.) MFM strategy development
3.) Key person/stakeholder analysis
4.) Establishment of MFM council
5.) Definition of key projects
6.) Business planning and financing
7.) Setting up MFM business units
8.) Setting up a regional MFM holding and Project Implementation

Material flow analysis (MFA) means assessing the current business as usual situation. It is a qualitative and quantitative assessment of the current flow of money, energy and materials in a region, as defined within the determined system boundary. Key points to look at are water, fuel, money, renewable energy potentials, and special aspects like tourism, etc. Examples of what can be included in an MFA are fuel consumption by type and purpose, fertilizer use and cost, organic fraction of solid waste, drinking water demand per day, incoming solar radiation, wastewater and resulting substances, etc. This information is what helps the project team come up with the **MFM strategy development**, i.e. preliminary ideas about what some key projects could be for the region. For example, if the region in question is very sunny and requires hot water for

a burgeoning tourism sector, the team may consider projects involving the distribution of rooftop solar water heaters. Alternatively, if a region has a problem with water sanitation and imports expensive fertilizer, the team could choose to investigate the feasibility of a small-scale bio-digester program that would help to solve the problems of sewage water, fertilizer, and energy simultaneously.

The next step would be the **key person/stakeholder analysis**, in other words finding out who is officially the person or persons in charge of a region, and who may be unofficially influential. On paper, the person in charge of a certain system or material flow could be the mayor of a township or the plant manager of a local factory. The "unofficial" key persons depend on the region in question, and can include aspects such as culture. Using the stakeholder analysis, we can plan the **establishment of the MFM council** who can help to procure financing and act as people who can keep the project going after the original team has left the area. Next comes the **definition of key projects** in a presentation to the key persons, making sure to impress upon them the importance and relevance of the suggestion in quantitative terms, i.e. what the investment cost may be versus how much money is being spent on inefficiencies of the current system that they may have not realized before and just taken for granted. Once the investment costs have been outlined, it is time for **business planning and financing:** while the initial costs seem prohibitive, it is often the case in the developing world that other developed countries may step in to provide financial assistance in return for access to a previously untapped market; this is the underlying principle of the CDM. Then they set up MFM business units and an MFM council to oversee the ongoing operations of the new system, and ensure that it is sustainable in the sense that it can continue itself.

Zero-Emissions Methodology

Similarly, **Zero-Emissions methodology** seeks a waste-free society. The ZE model has been included as it offers extra insights for steps that should be modified to better work for regions in Cambodia. It "aims at the achievement of socioeconomic systems, regional communities, and corporate management styles that do not create any waste products… by means of mutual collaboration between the various actors of the socioeconomic system" (Yamaji K, p. 2). This method places importance on the idea that the "eco-industrial park" is at the core of the system. In an eco-industrial park, wastes are avoided as much as possible by individual companies or systems, and any wastes that are generated are used by other companies as raw material. The major steps in pursuing ZE are as follows:

1.) Organization of an Investigation committee and pre-party investigation
2.) Investigation of actual conditions
3.) Identification of a basic plan and a promotion mechanism
4.) Preparation of a ZE plan
5.) Implementation, operation and commercialization
6.) Inspection and evaluation
7.) Improvement

Even more so than MFM, ZE methodology places heavy emphasis on stakeholder involvement. In fact, more stakeholders are involved from an earlier stage in the process. The point of **Organization of an Investigation committee and pre-party investigation** is for stakeholders to be sure everyone involved understands the basic concepts behind what they are trying to accomplish with a ZE region or system. **Investigation of actual conditions** involves getting a picture of the current system, what is being imported, how much is being used, etc. much like an MFA. **Identification of a basic plan and a promotion mechanism** again involves the stakeholders, ideally the main ones from the inside with the most motivation for having

a leadership position, but also leaving room for collaboration with actors such as local governments, other companies, research organizations and local citizens. A vision for eventual goals of the industrial park must be clearly stated for the mid- to long-term view, followed once again by disclosure of the plan to stakeholders. In **Preparation of a Zero-Emissions plan**, done by building consensus among the stakeholders on which material or waste streams are the most common, with plans to expand on them in the future. **Implementation, operation and commercialization** entail promoting the plan among employees or citizens to ensure their participation in the success of the program. This can be in the form of education or public relations activities. Implementation is not the end; **inspection and evaluation** is required to identify any weak points in the program. Actors such as companies report progress (or lack thereof) to the promotion body. The final step in the basic process is **improvement**: taking the lessons from the inspection step and making necessary changes.

4.2 How MFM and ZE Methodologies Can Help

The language used in MFM and ZE methodology suggests an audience geared more towards industrial management than in NGO-based development projects. Indeed, most of the areas that are using MFM systems thus far are usually SMEs, or in the so-called "emerging economies" that already have some infrastructure that can be improved, and money to spend on those improvements (Heck, pers. communication April 2011). Therefore, this section will point out areas in which MFM/ZE could be especially effective in development project planning, and why such a localised approach should be taken in the first place.

As mentioned before, Cambodia has ambitious plans for achieving a green economy

that accounts for issues of environment and poverty, but the situation on the ground level is different. While issues such as corruption play a part, it seems that a tool for implementation that shows the benefits in immediate, quantitative terms is lacking. Material Flow Management and ZE methodology have great potential for developing regions due to its holistic nature, and the importance it places on participation and stakeholder management.

The first point that makes MFM an effective implementation tool is its holistic nature that takes the entire system into account. There are various examples of issues that are the consequences of inefficient systems, and projects that solve multiple issues simultaneously. For example, in rural areas of Bangladesh, people who wanted light or power were using kerosene or paraffin lamps that caused indoor pollution leading to health problems, and spending money on costly fuel, preventing them from having the spending power that could lift them further out of poverty. However, the implementation of SHS distribution programmes by Grameen Shakti was able to combat all of these problems at once (UNEP, 2007). It would normally be unthinkable to bring such a perceived "expensive" source of power such as solar energy to villages like the ones found in Bangladesh, but recognition of the real costs of BAU, and using this to convince donors to participate, can make such activities very feasible and beneficial to these communities.

Secondly, the role stakeholder management plays in MFM and ZE methodology makes an effective potential implementation measure. All parties involved in or affected by any system change should be included in the process of devising the new system. In

other words, it is important not to alienate anyone early on in the process. Similarly, the PEI Handbook encourages participation of local people. Often times when devising development schemes, even “pro-poor” ones are unable to achieve what they were set out to do. The “ability to make [the general public's] voices heard may be weak or non-existent” and they are "generally disconnected from national development planning process” (UNEP&UNDP p. 22). This calls for inclusion of the poorest groups of population, integration of the voices of the poorest when defining the outcomes of the poverty-mainstreaming effort, and making use of their knowledge of poverty-environment issues at the grass-roots level (ibid). This principle is included especially in the UNU Tokyo ZE methodology, as mentioned before.

Promoting activities such as ecological agriculture and changes such as eco-villages and using renewable energies among the general public is always a challenge, and this is the case in Cambodia as well. The UNESCAP National Green Growth Roadmap describes several ideas for the implementation of such things, and an award system for achieving certain standards. This is a good first step, but awards mean little for the most marginalised people—the ones ultimately most responsible for sustaining such activities. They need to be able to see some concrete short-term benefit to living in an eco-village or participating in organic agriculture, such as saved time or money on buying food. MFM can help the general public understand why they should participate in these activities.

5. Sustainability Assessment and Preliminary Material Flow Analysis of the Trav Kod Reservoir and Canal Project

The author's task at CTO was to conduct a sustainability assessment of the project in terms of its impacts on the community's social well-being, surrounding environment, and economic development. For context, a background on the inception of HT/CTO is provided, along with a background on the Trav Kod reservoir project. The task was performed with an eye towards the steps of MFM, the first of which is a preliminary survey of the existing system. The paper was written with a preventive approach in mind. All ecosystems and projects can create a complex chain reaction, sometimes resulting in unintended consequences. It is therefore impossible to account for every single possible effect of a project. However, this section will attempt to identify the major foreseeable impacts. The possible effects of the Trav Kod project were assessed according to the following methodology: 1.) by reviewing literature on irrigation system projects and their typical major issues 2.) comparing and contrasting those situations with the system in place in Ballangk, pointing out which issues are or are not applicable in this case, 3.) demonstrating management measures CTO has already put in place, and 4.) offering recommendations on remaining issues with potential for future improvement.

Due to a lack of data, time constraints and language barriers, this analysis is very qualitative rather than quantitative. Performing a full MFA would require time, as well as financial and human resources that were unavailable in the two-month period in which the report was completed. However, the part of the point of the report was to advise donors and technical cooperation organizations on what projects should be

considered next, and that was accomplished. Other challenges in making this report centre on the current, on-going nature of the project, and difficulties in quantifying potential effects.

The reservoir and irrigation systems are relatively benign in and of themselves due to major differences between more conventional systems and those at Trav Kod. As mentioned before, even the most well-intentioned irrigation systems can present problems when they have not been planned and managed properly. Major issues include soil erosion, salinisation and increased alkalinity of soil; increased evaporation of water, drawing down of the water table which compromises future supply; decreased water quality due to erosion and agricultural runoff, disruption of existing ecosystems due to diversion of waterways, impact of producing the materials used in the water control mechanism, any electric power demand in the water distribution system, build-up of silt in the machinery, as well as socio-economic and health consequences such as increased prevalence of vector-borne or diarrhoeal disease that can appear with new sources of shallow standing water near human settlements (Dougherty & Hall, 1995) (Stockle, 2001) (WHO & STI, 2005). However, the Trav Kod reservoir has been planned in such a way that it already mitigates major issues caused by some irrigation systems for the reasons that follow in later sections of this paper.

Any potential issues the sustainability of the irrigation system will likely come from the flow of materials in and around the system (e.g. faecal coliform, pesticides, artificial fertilisers) and the capacity of villagers to spend their increased income in a way that benefits themselves and the village for the long term. Therefore, the approach to

keeping the system sustainable should keep the whole picture of the community in mind. MFA can be the ideal tool to do this, especially considering the interplay between the economic and social aspects of poverty, and environmental concerns.

5.1 Background on Community Translation Organisation and Ballangk Commune

Ballangk Commune

Ballangk Commune is located in Prasath Bakong District, Siem Reap province in the northwestern area of Cambodia. The commune is home to nearly 6000 people: 1559 men, 1493 women, and 2786 boys and girls under the age of eighteen (CTO, year unknown).

Siem Reap province is one of the poorest and most food insecure in Cambodia. This is in spite of the fact that the province boasts Angkor Wat, the country's biggest tourist attraction and, recently, a major cash cow. As can be deduced from general information on the condition of the country, the rural population is what is being left behind in terms of Siem Reap city's booming tourism and construction economy. It is a target area for the World Food Programme due to its need.

Like the rest of Cambodia, the area is subject to two major seasons: the dry and the wet season. Rice planting in Ballangk is done exclusively in the wet season, and the harvest generally is able to feed the people until May, which is a few months before the next rice harvest. What this means is that, during these few months between the planting and harvest time, those with the money must spend it on expensive out-of-season rice from the markets, and the less fortunate ones go hungry during this time. Hunger in

Ballangk has a host of direct and indirect consequences for human health and the social well-being of the commune's people, including adverse effects to school attendance, and domestic violence (Ya, pers. communication April 2011).

Human Translation/ Community Translation

Human Translation began as an individual project dedicated to the restoration of the Trav Kod Reservoir. Although the local people had tried to repair the reservoir numerous times, they ultimately failed due to a lack of financial and technical capacity. The monks at the local *wat* recognized this, and had petitioned local charity groups to no avail. One of these monks befriended an American backpacker in 2004, and took him to commune of Ballangk. Disturbed by the endemic poverty of the area for lack of something so fundamental to rice farming as irrigation, the backpacker and the monks founded Human Translation initially as a charity to raise the money needed for the reservoir restoration. However, they also became aware that money alone would not be enough, and enlisted the help of the New York chapter of Engineers Without Borders (EWB). At first, it was the intention of the organizers to phase themselves out of involvement with the village after the reservoir and irrigation systems had been finished. However, they and local scientists, engineers and project managers realized that there was more work to be done in the area, and formed HT's local subsidiary Community Translation Organization (CTO). Now, both NGOs are non-profit organizations working to promote economic development in rural areas of Cambodia through sustainable development services. HT International is mainly involved in garnering donations from international investors and generous individuals and companies, and CTO is its local implementing organization. From the Trav Kod project, CTO now works in the areas of:

1. Natural Resource Management (Consultation &Implementation)
2. Environment Education (EE) and Environmental Impact Assessment
3. Environment Protection & problem-solving
4. Organic based agricultural promotion
5. Irrigation System (design, construction and management)
6. Community Based Organization formation and capacity building
7. Credit Scheme Management & small enterprise development and management

Community Translation's philosophy is that rural people in Cambodia can improve their livelihood when they are given proper tools and capacity. "Raising People's Awareness Into Action" is part of their effort to empower people & communities to initiate and participate in sustainable development. Their approach is to give a strong value to natural resources and environment that is the foundation for the livelihood of a community.

CTO's projects include:

- Community Development & Economic Development Program
- Irrigation System Construction
- Capacity Building on Water Management to farmers' water user committees (FWUC)
- Aquaculture Promotion , Household Fish ponds , Fish Food Production
- Rice Yield Increasing , The System of Rice Intensification (SRI)
- Natural Resource Management (Community Forestry, Community Fishery and Eco Tourism)

7. Conservation

Community Translation has worked with many development agencies on:

• Commune Council and District Authority in Siem Reap in providing consultation on Natural Resource management & small holder construction projects
• Assisting commune councils to conduct environmental assessment of development projects funded by the government
• Providing service to government development projects in Siem Reap on the livelihood improvement program
• Providing technical support on engineering on irrigation system to district and commune authorities in Siem Reap

• Integrated community development (CTO Background). The organization operates mainly in Siem Reap province, but has recently branched out to projects near Sihanoukville (CTO, year unknown).

5.2 Trav Kod Reservoir project background

Figure 3. The Trav Kod Reservoir, Reconstructed

The Trav Kod reservoir has a history dating back to the Angkor Empire. It was a means of harvesting the heavy monsoon rains of the wet season and storing them for use during the extended dry season. In this way, farmers could plant crops year-round instead of exclusively during the wet season. The modern system had been built in the 1970s under the Pol Pot regime. However, the equipment fell into disrepair and the reservoir subsequently dried up. The villagers themselves attempted to repair the system alone, but these efforts ultimately failed for lack of technical assistance and financial resources. The project was revived in the past five years thanks to the efforts of Human Translation (HT)/CTO. The reservoir can hold approximately one Mm^3 of water and irrigate 2000ha of land area for 1100 farming families. There are currently 2000m of primary canal already built, with another 4000m currently being built, and a planned 18km of secondary canals (CTO, year unknown).

In addition to rebuilding the reservoir, the group is also assisting in putting in family fish ponds, stocking the reservoir with fish, and replanting trees and other specially chosen vegetation around the reservoir to control erosion and improve the environment for the fish. There are also plans to plant cashew trees around the 6000m of canals as a means of providing erosion mitigation, shade area for farmers, and extra income and food from the cashews.

5.3 Sustainability Overview

Social Impact

Perhaps the most obvious outcome of the project is its role in improving food security. Similar projects in other areas of Cambodia claimed

> "direct beneficial impacts on poverty reduction by (i) improving food security for rice-deficient households; (ii) improving access of marginal farmer households to irrigation through the construction of tertiary and quaternary canals; (iii) improving the access of landless households to rice lands through leasing of expanded irrigated land; and (iv) over a period of time, improving agricultural incomes through diversification of production" (Asian Development Bank, 2003).

Indeed, CTO estimates that the Trav Kod projects can double the rice output of the village. Rather than producing rice only once per year, storing water and sending it to the fields will allow farmers to plant in the dry season as well as the wet. The reservoir was stocked with fish, and CTO will assist in installing 50 family fish ponds to further help ensure that the community members have enough food to eat during the dry season months when rice previously was not planted.

The project is also meant to result in increased cooperation among members of the village. The establishment of the water committee comprised of villagers elected to be

in charge of the water places the power over their resource into their own hands. Women are especially encouraged to take part in the committee in charge of the water. This is in accordance with the Dublin Statement on water management that highlights the stake women have in handling water sustainably.

The immediate poverty alleviation effect of community forestry activities is debatable due to the relatively high amount of time input per actual dollar value requirement (Babon 2004). But, much like the buffering effect higher biodiversity has on an ecosystem, forestry can offer a certain "natural insurance" or safety net, making the people less vulnerable to sudden shocks or changes (Prom & Ballard 2005, CSES 2004, Chan & Archarya 2002, McKenney & Prom 2002 in World Bank 2006). Forestry activities also open up the possibility of revenue through CDM projects with international partners.

However, something to think about is the risk of disease associated with irrigation projects and shallow pools of standing water, such as vector-borne and intestinal parasitic diseases. According to WHO and the Swiss Tropical Institute, there is no direct causal link between increased irrigation area and increased presence of malaria; "whether an individual water project triggers an increase in malaria transmission largely depends on the epidemiological setting and socio-economic factors, vector management and health seeking behaviour....a combination of integrated malaria control measures and sound water management is essential to reduce the current burden of malaria in locations near irrigation or dam sites sustainably" (WHO & STI, 2005).

Malaria, haemorrhagic dengue fever, and other vector-borne diseases are endemic in certain parts of Cambodia. When the threat is year-round, it is mainly a risk to travellers, as local people tend to build a tolerance for the disease through repeated exposure. However, in climates with an extended dry season, immunity falls to the point where local people are at risk of contracting the disease as well (ibid.). In Siem Reap, there is a significant malaria burden out in the forests, and people do build up tolerance. The main at-risk group of people are males age 15-45, who sometimes travel from non-endemic areas to those with malaria, and who do not know about the threat or take proper precautions (Dolenz 2011, personal communication).

If the water in the canals is flowing quickly and continuously as it often does in the wet season, then there is little to no chance for mosquitoes to breed. However, in the case of a drought such as the "short dry season" that often occurs in July, there is an increased chance for puddles to form in the irrigation canals, thereby providing a breeding ground for mosquitoes. This chance is further increased if the water quality is poor, with the presence of algae and bacteria on which mosquito larvae feed. There is a possibility that people could take more precautions such as using bed nets against nuisance mosquitoes as their incomes rise. However, as there are various reasons to take care of the water quality beyond preventing vector diseases, we can say that the preventive approach is best.

Another area of possible health concern is gastrointestinal disturbances in the event that people drink the water from the irrigation canals, or swim, do their washing, collect cooking water or play in them. Only about 10% of Ballangk households have access

to well water. Once the canals are operational, it is perfectly understandable that the people will want to use the canal water near their house for multiple purposes. However, they need to be educated on the risks of drinking the water, and the importance of helping to maintain high water quality.

A disease associated with irrigation is Schistosomiasis, a chronic illness second in economic impact only to malaria (WHO 2010). The strain most relevant to Cambodia is the *schistoma mekongi* found exclusively in the Mekong river basin. To find relevance with the Tonlé Sap watershed, the National Malaria Centre conducted a study of the prevalence of Schistosomiasis in children living on the Tonlé Sap in 2006. The research found no incidence of the disease, and concluded that the water of the Tonlé Sap contains heavy amounts of clay, and therefore is too cloudy for Schistosomiasis-carrying snails to survive. However, they did find incidence of other helminth infections that can be problematic, especially in children with regard to school performance (Chhakda, Muth, Socheat, & Odermatt, 2006). That study focused on the Tonlé Sap itself, but the chances of contracting the disease is unlikely throughout the entire watershed (ibid.).

Therefore, while Schistosomiasis does not appear to be an immediate threat for the Ballangk area, there is a risk of other infections being transmitted in the canal water. In the short term, the water in the present canals should be periodically tested for the presence of pathogens, and the non-potability and risks of playing in the canal water could be worth noting in any community education activities regarding proper use of the water. In the mid-term, some potential projects to help with this situation would

involve improving access to safe water and eventually sanitation, examples of which will be discussed in the next section.

Environmental Impact

Human alterations to the surrounding natural environment are sometimes detrimental, but we should not automatically assume this in every situation. The function of Trav Kod as a reservoir is essentially a means of rainwater harvesting, and for controlling the flow and direction of water through the region. It harvests the abundant Cambodian monsoon rains for use during intermittent times of drought during the wet season, thereby providing a steady source of water during the dry part of the year. While there is a small stream providing water to the reservoir, the majority of the water in the reservoir is left over from the monsoon rains. Therefore, unlike systems that draw largely from groundwater resources, the Trav Kod reservoir does not significantly affect the aquifer in any way. In fact, using rainwater helps to preserve the already-stressed Siem Reap area water table. There is heavy civil engineering in place to control the flow of water from the reservoir, but this is not used to directly divert water from any major river source as often happens in more typical irrigation systems.

In addition, the water control mechanism is entirely manual and has no electricity demand–an important feature for a place with expensive electricity such as rural Cambodia. Manual use can take some working or farming time away from the users, but it gives the users a sense of responsibility over their water supply.

It is very arguable that the reservoir and its management actually make a positive contribution to the surrounding ecosystem. It is a source of life not only for the farmers

using its water, but for the quality and quantity of the surrounding forest. About 80ha of forest land have been added to the area surrounding the reservoir, from what was originally 37ha. The area had been subject to illegal logging by land speculators, but there is increasing understanding due to community education activities about the need for the presence of quality forest in order for all of the people to benefit from the ecosystem services it can provide. Increased forest cover is a priority for Cambodia, and forests act as a carbon sink. In addition to being better able to provide for immediate needs, a larger and higher quality forest is more bio-diverse—and a bio-diverse forest is better able to withstand storms and the effects of climate change. The reservoir and surrounding forest also provide for better temperature regulation against the heat.

However, there are some potential impacts to the environment. The sandy and sandy clay soil surrounding the reservoir and the canals is highly erosive. To mitigate this problem around the reservoir, Vetiver Grass was chosen for its erosion-slowing and water-cleaning properties (CTO, year unknown). As erosion could cause damage to the canals themselves, the main canals have been constructed according to these conditions. By constructing a slope three metres wide at the bottom and one metre wide at the top, a more gradual slope is created to mitigate erosion. In addition, local grasses were planted to hold more soil in place with the root structure, and rocks are placed in the effluent area to slow the flow rate and reduce erosion. However, this is unlikely to eliminate erosion completely, and therefore the erosion should be monitored. Soil erosion can also present a problem for water quality, as substances caught in the soil can be transported to the water as runoff.

When there is a risk of erosion, there is a risk of further damage to the water quality depending on what sort of substances are present on the fields. Farmers sometimes use a small amount of pesticide purchased at the local market on their crops, which could potentially run off into the canals. Additionally, the farmers mainly use raw animal waste as a source of fertilizer; this also has runoff potential that could cause additional nitrification and eutrophication in the water, especially when coupled with the erosive nature of the soil, and that could harm fish in the canals. As the villagers' income gradually increases and they grow more types of crops, they may choose to buy more pesticides and chemical fertilizer if they are not educated about the long-term drawbacks of these chemicals. Any reduction of quality in the canal water is not likely to affect the reservoir significantly. This is because the water in the canals is carried away by gravity, and will probably not flow upwards back into the reservoir unless there is a large rainstorm—but in that case, pollutants would be diluted.

At the time of writing, the villagers do not have improved toilet facilities in or around their homes. This presents similar problems to that of animal waste runoff, as well as increases the potential for diseases related to contaminated water, the effects of which were discussed earlier. It can be taboo to talk about the value or use of human and animal waste products, but they can be an important resource when the right technologies and management systems are applied. Left as is, the material represents not only a threat to the canal water quality and human health, but also a lost opportunity to create a power source and/or healthy treated organic fertilizer. It could therefore be worth looking into small- or micro-scale biogas systems to go with improved toilets, or lower-tech composting systems that can be constructed locally by the users themselves.

As mentioned before, there are direct consequences to human health and indirect social consequences to using the canal water for drinking, washing, or playing. To help prevent improper use of the canals, more people need access to safe water. The BAU scenario for giving more people access to safe water for household use would likely be the installation of more wells. However, the drawing down of the water table faster than it can be replenished is an emerging issue in Siem Reap, as the effects of more hotels is having on the temples of Angkor. The Ballangk community is of course, not at fault in this issue. However, implementing alternative ideas for meeting water needs could make the area a showcase for smarter water use that other areas of Siem Reap could follow, and help attract eco-tourism attention to the area. Ideas include but are not limited to low-tech rainwater harvesting and storage systems for household uses like washing clothes or bathing, and implementing programs such as Solar Disinfection (SODIS) water treatment activities in the community for safe drinking water. If these projects targeted schools, they would also improve conditions there and encourage school attendance[1].

There is no absolutely no disputing the value of increased rice production for the people of this commune. However, in the context of assessing potential environmental impact, it should be noted that rice production can produce high amounts of methane (which has a global warming potential of 241 times that of CO_2) and nitrous oxide (with a GW potential of up to 300). Rice-related methane makes little contribution to the global share of greenhouse gases, but it accounts heavily on the national scale in major

[1] SODIS, promoted by WHO, maintains that clear but microbe-contaminated water can be disinfected by placing water-filled PET bottles in direct sunlight for an average of 6 hours. Cloudy water requires filtering beforehand, but can still be disinfected in this way.

rice-producing countries such as Cambodia.[2] Amount of GHG released depends largely on the type of rice and method used for cultivation. In the case of the rice grown in the dry season, the paddy is not flooded. This is one of the less methane-producing methods of growing rice, thus lessening the impact of increased rice production. While it is therefore not an immediate concern, the rice-methane issue could be something to keep in the mind for future projects.

Another area that has high value for the people is aquaculture. As with increasing rice production, there is no question that more fish farming creates more food security to the community. However, poorly managed fish farms have some impact. Depending on the scale of the fishery operation, these impacts can include biological hazards and risk to farmed animals, people, and ecosystems; infectious diseases, animal pests, and public health concerns on residues and resistance of antimicrobials used in fish production, zoonosis[3], invasive alien species, possible release of genetically modified organisms into the environment, and biosecurity risks posed by climate change. These impacts are minimal in small, subsistence-based operations (FAO, 2010). This is intended to be the situation in the commune in the short term. However, should the catch prove to be profitable, many communities increase production, and the risk increases with the scale of production. However, risks can be mitigated with integrated strategies to manage biosecurity, business, and environmental and social risks and better promote the growth of aquaculture (ibid.).

If the people find that raising livestock is profitable, they may increase production in

[2]www.irri.org
[3] Diseases transferred from animals to humans

this area as well. An issue to think about in this respect is the high water demand on raising livestock, particularly cattle, as opposed to vegetables and rice.

Economic Impacts

In a subsistence farming community, it can be tricky to quantify economic effects in dollar amounts. Economic effects will be counted in dollars where they can be, but in other areas they will be measured in terms that are more pertinent to the community, e.g. number of jobs created, kilograms of rice, etc. Instead of using heavy machinery to construct the canals, villagers were hired to do the digging manually and paid in rice donated by the UN WFP's Food for Work (FFW) programme. A total of 22,750kg is being distributed to 216 participants, giving them an average of 105kg per person over the course of the construction period. Since most farming activity is done during the rainy season, the construction took place in the dry season. During this time, there is little to do on the farms, and farmers often seek other work outside the village to supplement their income during this time. The participants in the dig were happy with the amount of rice they received, and having been a part of the construction gives them a sense of ownership over their canal (Ya, pers. Comm.., April 2011). To ensure sustainability after the project is phased out and handed over to the village, farmers will pay a fee to use the water, which will go towards maintenance of the canals. Maintenance will be carried out by the people who constructed it.

The villagers who are fortunate enough to have a bit of money to buy rice during the dry season will be able to save or use that money for other things, and the ones who do not will still have more food security. Irrigation and training will yield more diversified crops. For example, CTO plans to plant cashew trees around the canals, which could

yield up to $22,500 in income from selling cashew nuts. From family fish ponds, villagers will be able to collect 120 kg of fish two times a year per pond, contributing to food security and an important source of protein to about 248 people directly. The fishery programme was specifically targeted at financially vulnerable groups such as female-headed households and the disabled. They will average $250/annum from animal husbandry.

Some potential economic issues to think about in the future include shifting from dependence on outside grants, and ensuring that this new purchasing power will be reinvested in such a way that is positive for the community. It is wonderful that private donors and organisations such as UNDP and AusAid have seen the potential of this project and been as generous as they have. However, CTO has already recognised the importance of finding a source of income from within so that the village can find its own sources of income between projects and grants.

Another question that arises in this case concerns reinvestment into the community. All going well, community members will have more food security and more purchasing power as a result of this project. But, a relevant question to ask is, how will they spend this money? Will it be in a way that helps the village achieve goals set out by the UN MDGs and CMDGs? Will it help the village achieve its own goals (and for that matter, what *are* the long-term goals of the village)? Will it help continue to add value to the region? Or will it put them in a place slightly ahead of where they were before, but still not advancing? For example, if the money is used to buy children's school supplies or a bicycle that a villager uses to sell palm juice to a larger number of people, this would

be an example of investment and added value. But, if a farmer uses the money to buy chemical fertilizers or expensive car battery electricity, that is tantamount to money leaving the region, which will cause detrimental long-term impacts to the environment and the soil quality, and putting the farmer in another place of dependency. That would contribute little to the added value of the region.

Part of the point of the reservoir project was to free people from "survival mentality." When people have enough security in their food supply and are confident that they can meet their daily needs, they will be better able to plan for the future. Therefore, the next steps could be to find a common vision of what the village may look like in five, ten, or fifteen years' time. If we want to make sure the money will be reinvested in a positive way, it is essential to establish what is considered to be "positive."

5.4 Conclusions and Next Steps

While some irrigation systems stress aquifers and river ecosystems, the Trav Kod reservoir and irrigation system is not only benign, but it is also an example of effective rainwater harvesting and management. Its construction and management has been planned in such a way that it gives responsibility to the users themselves, and improves food security not only immediately through the FFW programme, but also for the future as farm yields increase through more continuous water availability.

Potential issues with the system involve the flow of materials through the canals, rather than the system itself. Establishment of some kind of sanitation and improved toilets is a good idea and an end unto itself, but the presence of an irrigation system makes the need more urgent as water flowing around a village could exacerbate problems that

already exist when sanitation systems are not in place. Sanitation combined with methods for home-grown safe water obtained in a sustainable way, and education on the connection between proper canal water management and health will prevent potential problems, and can also be important next steps in adding value to the area.

Finally, there should be some kind of master plan for projects so that the commune can reach its full potential. A master plan would benefit CTO as well, in that it would give the organization a framework to be using instead of being dependent on donor money for isolated projects. In addition to improved sanitation and education on sound water management and health, next steps should include incentives for people to reinvest their newfound spending power into the increased well-being of their community. A master plan such as the one that MFM methodology condones would help to achieve this as well.

6. Discussion

This section is intended as an interpretation of the previous literature review and connection to the situation in Ballangk. It will consider the extent to which we can consider the Trav Kod project to be an example of MFM. Then, given the recommendations from the sustainability and poverty alleviation effects of the project, it will explore what MFM can do to make the system better for the future. It will point out steps in the methodology that require special attention or changes for this type of area. Then, it will point out some challenges that, while relevant for any project or organization in Cambodia or the developing world at large, can present limitations to what MFM can do. Finally, it will propose some potential areas for further research.

6.1 Similarity and differences between Trav Kod project and MFM

While the Trav Kod project was not an MFM project in the usual planned sense, it did have a lot of similarities to the way MFM is done. It is even tempting to refer to HT/CTO as "accidental material flow managers."

Before implementing an MFM project, an MFA is usually done. In this case, there was a preliminary survey of the way the village operated. While the groundwork for a more extensive MFA[4] has been laid down since the NGO decided to expand its activities beyond the reservoir and irrigation system construction, no extensive data collection had been conducted at the time the reservoir construction project was planned. However, in this case the need was painfully obvious; an operational irrigation system is fundamental to conventional rice cultivation systems in Cambodia. Those buying rice after supplies ran out amounted to money leaving their local economy. People going

[4] Compiled by former CTO consultant Kristen Davies

hungry meant that human welfare, well-being and overall development potential was leaving the region, resulting in negative added value. CTO was able to recognize this without the kind of extensive data collection for the initial stages of the project. However, as the scope of the NGO's activities expanded, they found it necessary to do a survey of the people living in the village, i.e. number of men, women, children, female-headed households, elderly, disabled, etc. This was important in choosing the best people to target for other objectives that came up, as will be discussed later.

The next step in the process is Strategy development, and HT did that. Put simply, the strategy was to rebuild the reservoir. However, the way they did it was important: they had to be sure that the donor money they received was put to good use and that the reservoir would not fail this time. More importantly, the NGO was sure to include local people in the process by creating incentives: locals out of work (and rice) in the hot season were paid for their labour in rice from the WFP's FFW programme.

The key person/stakeholder analysis was crucially important in this case, and perhaps the most prominent feature about the development of the project. MFM encourages managers to talk to the very people involved for ideas on how to improve the targeted system. The idea for the restoration of the reservoir came from the people themselves. Older members of the village remembered being able to grow rice twice a year when its irrigation system was fully operational. In terms of Cambodia's culture, Buddhist monks play a vital role in the dealings of village life. In this case, it was the monks of the local *wat* who served as the initial go-between between the local people and the backpackers who brought the idea to implementation.

After doing a survey of the people living in the village, CTO made sure to target the most vulnerable people such as female-headed households and the disabled for special segments of the project like fisheries and the FFW in the canal digging process. This was largely at the behest of donors such as UNEP or UNDP who factor in women greatly in development and the achievement of the MDGs.

The "key projects" of this operation are as follows: initially it was the reservoir and the canals alone. But at further request from the people, the project branched out to include fish stocking in the reservoir, home fish ponds, and community forestry that would add income and a better habitat for the fish in the reservoir. "Business planning and financing" is where we begin to see some departure from MFM-style projects, and more resemblance to a conventional development activity. Financing is still very donor dependent, and not necessarily meant to generate income. However, it is important to note that the main goal of farming in Ballangk and other communities like it is subsistence and food security, not necessarily income. That said, later stages of the project hope to promote vegetable farming, animal husbandry, potential income from sustainably harvested timber and NTFP, and the growth of cash crops such as cashews. While the element of concrete "business planning" is not present, it is something CTO is aware of for future activities.

If we give a loose interpretation of "business units," we can consider them to be the water user groups and forestry groups in this context. These groups, along with the commune council, the monks and CTO itself, seem to be the regional holding authority.

Therefore, we can to a certain extent consider the Trav Kod project to be MFM in some ways. However, due to more abstract, linked benefits and subsistence nature of a lot of the people's activities, we can not necessarily look at the benefits or results in concrete dollar amounts. This presents both opportunities and challenges for using MFM in marginalized rural communities.

6.2 What MFM Can Do for Ballangk

The assessment portion of this paper pointed out the benefits of installing sanitation and/or a bio-digestion system, and also pointed out potential consequences of *not* having these things alongside the irrigation system. CTO did, in fact, apply to UNDP for a bio-digester system, but with rather vague specifications for such a system. As such, they were rejected for equally vague reasons of "non-feasibility." Now, the bio-digester question could be worth revisiting with an eye toward the MFM of the region. While the supporting application documents for the bio-digester system are in Khmer and were not available for this paper, the author suspects that the system would have been somewhat centralized and only meant to collect animal waste. That would make collection difficult in a place where the substrate is typically left to its own devices in the rice paddies or in the soil.

Related to this question, the assessment also called for better access to electricity and cooking gas for the village. A biodigester would help to improve sanitation *and* grant a better electricity supply to the schools, *wats*, and community centres, a clean source of cooking fuel to households, or both. It is very expensive to extend electricity from the

main grid to the rural areas, and equally or more expensive for people to use battery charging stations or diesel generators. Therefore, renewable-based electrification is an attractive option. If an MFM approach were applied to Ballangk, comparing the probable costs of a biodigester and sanitation compared with a conventional sanitation system and other methods of electrification or biomass for cooking, the biodigester may look like the better option. MFM can also help to implement the other project ideas that came out of the sustainability assessment.

In addition to making "unfeasible" projects work for Ballangk, MFM can help CTO itself grow as an NGO. From their inception until the present, they have been dependent on donor money for individual projects. In fact, the plan was to dissolve the organization after the Trav Kod reservoir project was completed. However, they realized that they are able to employ Khmer engineers and agricultural scientists with the work they are doing, and it is therefore in the interest of everyone involved to remain in operation. Therefore, they are now trying to move away from dependence on donor money for individual projects to something with a wider "master plan." With the longer foresight an MFM master plan yields, they will be able to find more financial security as an organization.

6.3 What MFM Practitioners Can Learn from Ballangk

While the work there is far from finished, the Trav Kod project and the situation in the Ballangk commune can teach us many interesting points about doing MFM in impoverished rural regions. MFAs must pay attention to poverty-environment linkages. Factors such as frequent illness from hunger or lack of sanitation leading to

low school attendance rates are difficult to quantify, but should nevertheless be recognized as negative added value in the region. The makeup of the population in an area like this is a factor to consider in an MFA as well. CTO surveyed the number of female-headed households as a way of targeting those most in need of the benefits of their projects.

Another crucial factor is stakeholder management. It should go without saying that the beneficiaries need to be included in the process of putting poverty-alleviation projects together, but this is sadly not often the case in such projects. Donor organizations are still doing "relief," e.g. simply giving food to food-insecure communities rather than giving them the tools to meet their own needs indefinitely (Ya, pers. comm., April 2011). With the exception of the founder and a few foreign consultants and interns, the technical side of CTO is largely a Khmer-run enterprise. Until recently, they have worked intensively on one area, allowing for a more meaningful interaction with the people living there than what can normally be afforded. The author has observed that the people working for CTO have gone deep into the village, drunk the villagers' home-brewed palm wine, and worked hard to earn their trust. In return, the people have grown more receptive to new ways of doing things as taught by the staff of CTO. In a place such as Cambodia where the people have learnt to live for today and let tomorrow take care of tomorrow, such trust is essential when convincing people to delay gratification, as is often required of MFM, or any environmental-development projects.

6.4 What role would MFM have in the case of poverty alleviation?

In the case of Ballangk, the MFM process began with the recognition of an immediate need of improved food security, delivered in a way that empowers the people to obtain it

for themselves. It was MFM in the sense that it recognized the untapped resource of stored rainwater for irrigation, and used hearsay to assess the extent to which it would improve rice yields. In that sense, MFM can be used to bring about some kind of catalyst project to meet the area's most fundamental need. All other goals of MFM: electrification, improved drinking water, even sanitation are secondary to getting enough food to the people.

Therefore, to do MFM in a rural subsistence community, it may be necessary to start with some kind of "catalyst project" to meet the most immediate need, in this case food security. The engineering officer at CTO pointed out the host of consequences to a poorly fed village population, ranging from low school attendance to sickness to domestic violence. Once this immediate need is met, the people can begin to think about the other things that a village system optimised by MFM can bring. Financing for the catalyst project will probably come from international development donors such as UNEP or the World Bank rather than investors. MFM practitioners typically try to convince companies to invest money or technology into the system in hopes of turning over a profit, but the fact is that doing business in impoverished reasons is not the most attractive investment opportunity for most conventional investors. However, once the immediate need is met through the catalyst project, MFM can bring more projects that are financially interesting to investors to the area.

6.5 Limitations of MFM in rural Cambodia

Material Flow Management has its limitations, and working in impoverished rural regions is no exception. The main challenges to using MFM in this type of region concern financing, corruption, and quantifying the poverty-environment linkages in an

MFA. The moneymaking potential in these regions is not immediately apparent. For example, an MFM project on the construction of a mini-grid was attempted in Rwanda, but the only willing donors were development aid agencies rather than the kind of investors that MFM usually seeks (Heck, pers. comm., March 2011). This can create a dependence on donations, as experienced by CTO. The concept of making money off of disenfranchised people in rural areas can raise ethical concerns as well, especially in the development community.

6.6 Other potential areas of study and research

This paper is intended as an overview of the situation for using MFM in Cambodia at large, and specifically in Ballangk Commune in Siem Reap. As such, it has opened up other potential questions for further, more specific and data-intensive study.

The first regards the question of a "catalyst project" for especially needy areas of Cambodia. As mentioned before, irrigation during the dry season will improve food security for the area, and improved food security will contribute to greater progress in myriad other ways. In this way, food security was the primary condition that needed to be met before all others, and the Trav Kod reservoir project was the catalyst for other projects for further development. It is also noteworthy to consider that only a small fraction of Cambodia's rice farming land is irrigated, and the country hopes to increase this area—but this is, according to more archaic environmental management thinking, in conflict with the stressed groundwater and river ecosystems of the greater Mekong. However, it became apparent that the Trav Kod project utilized rainwater to meet this irrigation need, thereby using the seasonally-abundant resource in a way that meets the needs of the village while minimally compromising other forms of natural and tourist

capital (e.g. the underground aquifer supporting the Angkor temples or the river ecosystems, etc.). This condition of seasonal rainfall fluctuation affecting food security is widespread in Cambodia, especially in the poorer regions; however, Prasath Bakong has its own local topography and conditions, and MFM would caution against applying the same technologies to multiple areas without prior study of the local area. As such, it may be interesting to study the extent to which rainwater catchment-irrigation projects could be replicated in the country to help improve food security in poorer regions, and whether they could be the catalyst for more activities as we have seen in Ballangk.

Another area of study for MFM in Cambodia is in tourism. Tourist numbers are exploding in Siem Reap, stressing the ecosystems and very historical attractions on which the tourist dollars depend. Like the rural areas, a feasibility study of rainwater catchment to mitigate groundwater extraction stress could be of interest, as could projects like using kitchen wastes from the restaurant sector for biogas production, and improved wastewater sanitation for the city. Finally, CTO has begun educating local farmers on the causes and possible consequences of climate change, and how to adapt to the possible changes. Examination of ways to use MFM to create more resilient local economies and farming systems would be an interesting project as well.

In short, the Trav Kod irrigation project in Ballangk, Prasath Bakong, Cambodia was a sort of "accidental MFM" in terms of the steps involved with bringing the project to fruition. It is important to consider the linkages between environmental degradation and poverty in any MFA. These linkages can be difficult to quantify; however, an

extensive quantitative MFA is not of the greatest importance when the primary need and key project for this area is as obvious as it was in Ballangk. Because the moneymaking potential is not as clear from the outset as environmental projects can be, financing these types of catalyst projects will likely have to come from donors rather than investors. However, MFM can be a way to transition from donor dependence to autonomy and sustainability.

7. Conclusion

Cambodia is a country emerging from its dark period, and many challenges still lie ahead. Nevertheless, potential ways to help the country to meet the needs of its people sustainably do exist. International development authorities as well as the Cambodian government are starting to recognise the link between natural capital and human development, and its preservation as a requirement for a solid economy, rather than a roadblock to development or something to be exploited to its last. However, there still exists a gap between theoretical understanding and widespread practice. At local levels, non-governmental organisations are working to close this gap.

In particular, Human Translation/Community Translation Organization come from the ground up to design a smart, pro-poor, and socially inclusive system that gives the people of Ballangk Commune, Siem Reap province the tools to meet their food security needs. In fact, the Trav Kod reservoir project has many traits of material flow management, whether it was intended to be such a project or not. It has added value to a marginalised community and changed the lives of nearly 6000 people. However, there is still more work to be done if it is to become a model of the type of local green economy that Cambodian communities could potentially boast, given the right tools and investment. Material Flow Management has the capacity to help NGOs and local communities design more projects such as these, complete with the more long-term master plans they need to make "unfeasible" projects more possible and attractive to potential donors and investors.

Special points that arose during the course of the Trav Kod project include aspects of

stakeholder management, and the inclusion of the aforementioned environment-poverty linkages in a regional material flow analysis. In Ballangk, the need for a kind of "catalyst project" that should be prioritised before doing anything else was apparent, and this may be the case in other areas of Cambodia and the developing world as well.

Like any other anti-poverty tool, material flow management is not the magic bullet to the salvation of all the beautiful but blighted countries of the world. But it can be one of many mechanisms to bring Cambodia to the place it can be, where it deserves to be, and to ensure that can continue progressing in a positive way.

Works Cited

Asian Development Bank. "Report and recommendation of the President to the Board of Directors on a proposed loan to the Kingdom of Cambodia for the Northwest Irrigation Sector Project." 2003.

—. Status and Potential for the development of biofuels and rural renewable energy: Cambodia. Mandaluyong City, Philippines: Asian Development Bank, 2009.

Babon, A. Community Forestry as a mechanism for poverty alleviation: a case study from Cambodia. Melbourne: Royal Melbourne Institute of Technology, 2004.

Bruntland, Gro Harlem et al. "Report of the World Commission on Environment and Development: Our Common Future." 1987.

Chhakda, T, et al. "Intestinal parasites in school-aged children in villages bordering Tonle Sap Lake, Cambodia." Southeast Asian J Trop Med Public Health (2006): 37(5):859-64.

Dougherty, TC and AW Hall. Environmental impact assessment of irrigation and drainage projects. Wallingford, United Kingdom: United Nations Food and Agriculture Organization, 1995.

Glavic, P and R Lukman. "Review of Sustainability Terms and their Definitions." Journal of Cleaner Production (2007): 1875-1885.

Human Translation Organization. Progress Report of Trav Kod Watergate Construction, Embankment Repair, and Erosion Mitigation Project. Siem Reap: Human Translation Organization, n.d.

IfaS & BMU. "Zero Emissions: Recognising the Potential, Optimising Processes, Creating Added Value." Berlin: Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU), June 2009.

Kingdom of Cambodia. National Ministerial Roundtable on Green Growth Roadmap: Summary Report. Siem Reap, Cambodia, 2011.

Ministry of Tourism. Tourism Statistics Report. Phnom Penh: Royal Government of Cambodia, 2010.

Royal Government of Cambodia. "Cambodia Millennium Development Goals." 2009. Ministry of Planning. 23 March 2011 <http://www.mop.gov.kh/Home/CMDGs/tabid/156/Default.aspx>.

—. Cambodia: National Strategic Development Plan (NSDP) 2006-2010. Vientiane, 2006.

—. National Strategic Development Plan 2006-2010. Phnom Penh: Royal Government of Cambodia, 2006.

—. "National Strategic Development Plan Update 2009-2013." 2009. Ministry of Planning Cambodia. 23 March 2011 <http://www.mop.gov.kh/Home/NSDP/NSDPUPDATE20092013/tabid/206/Default.aspx>.

Stockle, Claudio. Environmental Impact of Irrigation: A Review. Pullman, WA: State of Washington Water Research Center, 2001.

The Independent, UK. "Heritage Site in Peril: Angkor Wat is Falling Down." Independent UK. 14

March 2008: http://www.independent.co.uk/news/world/asia/heritage-site-in-peril-angkor-wat-is-falling-down-795747.html.

UN Food and Agriculture Organization. State of the World's Fisheries and Aquaculture. Rome: Food and Agriculture Organization of the United Nations, 2010.

UNDP & UNEP. Mainstreaming Poverty-Environment Linkages into Development Planning: a Handbook for Practitioners. Nairobi, Kenya: United Nations, 2009.

UNEP. "Best Practice: Bangladesh Solar Home Systems." 2007.

United Nations Capital Development Fund. Local Development Outlook: Cambodia. Trends, Policies, Governance. Phnom Penh: Reaksmey Angkor Publications, 2010.

United Nations Development Programme. 19 March 2011 <http://www.un.org.kh/undp/what-we-do/environment-and-energy>.

United Nations Environment Program. "Green Economy Report." 2009.

United States Central Intelligence Agency. CIA Factbook: Cambodia. March 2011. 19 March 2011 <https://www.cia.gov/library/publications/the-world-factbook/geos/cb.html#top>.

WHO & STI. The effect of irrigation and large dams on the burden of malaria. Geneva, Switzerland: World Health Institute and the Swiss Tropical Institute, 2005.

Williamson, Andrew. Biofuel: A Sustainable Solution for Cambodia? Phnom Penh: Cambodian Research Centre for Development (CRCD), year unknown.

World Bank. Poverty Environment Nexus: Sustainable Approaches to Poverty Reduction in Cambodia, Lao PDR, and Viet Nam. Washington DC: World Bank, 2006.

Yamaji K, Mitsuhashi T et al. Zero Emissions Manual: Realizing a Zero Emissions-based Regional Community (English Version, First Edition). Tokyo: United Nations University Tokyo and The Development Bank of Japan, n.d.

Yandle, B, M Vijayaraghavan and M Bhattarai. "The Environmental Kuznets Curve: A Primer." PERC Research Study (2002): 1-23.