

Humanitarian Engineering Brief

**A collaboration between Akorn Educational Services,
Engineers Australia, Engineers Without Borders and WorleyParsons**

Scenario Outline:

Travelling through Cambodia on a holiday, Alex stopped at the Tonlé Sap Lake. She had allowed three days there to explore the area. Alex met Sam, a volunteer from Live & Learn Environmental Education, a non-profit organisation, who was developing a program for a disadvantaged community living in a floating village. Sam began to describe the everyday living conditions of many of the communities on the Lake, particularly the circumstances of a family he knows where the parents are raising three small children, two boys and a girl, aged 4, 7 and 11 respectively.

This family live in a small floating house that only has three rooms and some of their extended family also live with them. Alex notes that this must be cramped quarters for nine people, however Sam says this is often the case. The family work collectively, going out on their one rickety boat to source firewood to burn in order to cook and fish for food, with the surplus providing income at the markets.

As the family's one boat is needed for fishing, it is difficult to get the kids to the nearby school. As the kids have grown older, they have preferred to stay home to help with the chores, however Sam suspects that this is because there is no toilet at the school – he knows that many students in the area are embarrassed to squat over the side of the school into the lake where they can be seen by people passing by. As most of the boats in the area are a combination of row and paddle boats (the more affluent families in the area have motorized boats, and many of these are poorly maintained, run inefficiently and leak petrol into the lake), it takes considerable time to take the kids to school, decreasing the available fishing time and increasing the time for which the kids have to hold on before they can use a toilet at home (which provides privacy, but also empties into the lake).

Sam also tells of the continual threat of illness which this and many other families face as all of their drinking water comes from the lake, while their washing water, cooking water and any waste (for example human and

animal defecation), is dumped back into the lake. The youngest of this family is currently ill, and other members of the family must take time away from their usual work to care for him. The family are worried about the expense of taking him to a doctor and they become increasingly worried when he does not recover as quickly as is usual; the largest cause of death amongst children and babies in Cambodia is diarrhoea.

Luckily, this family owns a few pigs and other animals and can sell these precious assets if necessary. Sam also believes that the pig waste in the water is contributing to the family's often sick state. He also mentioned that the family's matriarchs have a bad chest affliction due to the wood stove they use to prepare and cook the family's food.

Alex puzzles over what Sam has told her; there are so many issues facing this family that are things just taken for granted in her home of Australia and many are problems that could be addressed by engineers. She knows of an organisation in Australia, Engineers Without Borders, which her employer sponsors, that work to address the disadvantage faced by communities. She mentions this organisation to Sam, who cautions that any "outside" help must listen and work with the community to have any chance of success. Sam has seen many instances where foreigners have come to "help" but have instead created more problems, such as the many wells dug around Cambodia which have now been found to contain arsenic. Alex doesn't think this will be a problem as EWB is known for acting with an "assets based" approach to development that ensures the community decides what they need and use the assets they already have in the planning, conceptualisation and operation of the projects. EWB would like to begin to research possible avenues through which their volunteers can assist the community.

Your task is to help Alex provide some solutions to the problems outlined in this booklet (use all the information provided you can) faced by the communities living on the Tonlé Sap Lake. In groups, you will need to decide what issue you would like to address (from the themes attached), what section of the community you are focussing on, how the issue is best resolved, whether any assets based methods or community consultation is required and what materials or expertise your idea involves.

After working through the issue with your team, you will provide a short presentation to the group explaining the reasons for your choice.

Scenario Aims:

- To show you what a wide range of activities engineering is involved in;
- To enable you to learn about the complexities of engineering and design in a real life international context. Sustainable development and appropriate design are equally critical here in Australia and New Zealand and indeed in all your future work;
- As engineers, planners and designers, you will be required to develop engineering and design solutions that are tailored to the local social, cultural, political, environmental and economic context;
- To appreciate the impact your decisions and actions have on the broader community;

This brief also represents a chance to reflect on the bigger issues of poverty and sustainable development and your role in responding to them. Although there is no shortage of challenges, there is also no shortage of great ideas to solve them.

Fact Sheet: Cambodia

Full Name	Kingdom of Cambodia
Land Area (sq km)	181,035
Population Size	14,071,000
Population Density	77.73
Year of Independence	1953
GDP per capita (\$US)	384
Age Structure	0-14 years: 34.0% 15-64 years: 62.4% 65 years and over: 3.6%
Ethnic Groups	Khmer 90%, Vietnamese 5%, Chinese 1%, other 4%
Languages	Khmer (official) 95%, French, English
Religion	Theravada Buddhist 95%, other 5%

(Source: <http://www.livelearn.org/country/cambodia.asp>)



7.1 Working in Cambodia

Cambodia is located in Southeast Asia and shares a border with Thailand, Laos and Vietnam. It has a land surface of 181,035 km² and a population estimated at 14 million, growing at an average annual rate of 2%.² Khmer is the language spoken in Cambodia.

Cambodia has a rich history. In the 15th century the Khmer empire extended across Southeast Asia, including most of modern Thailand and southern Vietnam and left a rich archeological legacy, with the temples at Angkor, namely the Angkor Wat, featuring among the grandest and most visited religious structures in the world. However, more recently Cambodia has struggled to survive as an independent nation - thirty years of civil war ravaged the country, including the infamous period of the Khmer Rouge (1975-79).

Cambodia's economy has been experiencing strong growth in the past few years, averaging 11.2% per year.² However, the Gross National Income (GNI) was still only 540 USD per capita in 2007, compared with 35,960 USD per capita in Australia.⁹ Of note, Cambodia ranks 129th out of 177 countries in the Human Development Index ranking.² Literacy rates are 85% for men, 64% for women and 74% total.⁸



Fact Sheet: Tonlé Sap Lake

The Tonlé Sap Lake is the largest lake in South-east Asia. It covers 1.6 million hectares in the wet season and decreases to one fifth of that area in the dry season.¹ The lake is fed by the Tonlé Sap River that reverses its flow in the monsoon season. This is one of the few rivers in the world to do so. In 1997, the Tonlé Sap was recognised by UNESCO as a Biosphere Reserve. Khmer is the main ethnic origin of Tonlé Sap communities, with minority groups consisting of Chinese, Vietnamese and Cham.¹

Some 32% of Cambodia's population lives in the Tonlé Sap basin¹, which covers 80,000 km² or 44% of the country's total land area. 340,000 people live in the immediate vicinity of the lake and are highly dependent on fish and other aquatic resources.¹

The communities live and work largely on the water, either in floating buildings and boats that are moved seasonally with the lake levels; in stilted houses which are surrounded by water during the wet season and become land based in the dry, or in small portable land based houses that are carried across the land according to the height of the lake. Less than 10% of the people living on or around the lake have access to safe drinking water or appropriate sanitation.¹ 37% of the population on and around the lake lives below the poverty line.¹

The lake is also home to an amazing biodiversity. Up to 400,000 tonnes of fish are caught every year on the Tonlé Sap, making it the richest fishery in the world (in fish caught per capita). These fish provide up to 80% of the total protein intake of Cambodians.¹ The lake contains 225 different species of fish, 42 species of reptiles, and 46 species of mammals.⁷ It sustains the largest colonies of water birds in Indochina, mainly at Preak Toal, a bird sanctuary.⁷ In addition, the lake's floodplain produces 12% of the total rice produced in Cambodia and more than 200 species of plants are found in the Tonlé Sap.⁷



7.2 Live & Learn Environmental Education working with communities



Working with communities starts with basic needs such as access to safe drinking water, nutritious food and basic sanitation. Live & Learn's approach to community intervention involves consultation with the community and assisting them through the process of identifying their own needs, through to assisting in the implementation of appropriate, sustainable solutions. This gives ownership to the community of the problems identified and actions taken to solve them. Too



EWB working with Live & Learn

In mid-2007, Live & Learn's office in Phnom Penh, approached EWB to develop designs for latrines suitable for use in floating and stilted villages in Cambodia's flooding regions. The New South Wales Technical Assistance Network (NSW TAN) took on this role and met regularly to workshop and develop the latrine design. The team was assisted by Live & Learn and an EWB Australia volunteer in Cambodia who provided information on local practices, materials and costs.



EWB volunteers in Cambodia have also engaged with the Engineering Institution of Cambodia. The Institute's youth chapter is providing volunteer assistance to the latrines project through advice, document review, and technical input. The team has also had input from another EWB partner organisation in Cambodia called Resource Development International - Cambodia (RDIC).



The environmental education work of Live & Learn aims to reduce poverty while creating a sustainable future.

Live & Learn Environmental Education (Live & Learn) is a non-profit organisation that works in action-focused environmental education. It was created in 1992 in northern Queensland, Australia. In 1997 it moved to become an international organisation with projects across several nations in the South Pacific, Indian oceans and Southeast Asia: Papua New Guinea, Solomon Islands, Vanuatu, Fiji, Cambodia and the Maldives.



Live & Learn has several projects in Cambodia. One project focuses on environmental education, sustainable livelihood and human rights which engages with communities living on and around the Tonle Sap Lake and River.

For more information on Live & Learn projects, please visit their website at www.livelearn.org





The Millennium Development Goals (MDGs) are a set of eight initiatives put forward by the United Nations to meet the needs of the world's poorest. Through the application of science and engineering, humanity has the potential to meet all of its basic needs: water, sanitation, food security, shelter, energy and transport.¹¹

Consider the impact of water and sanitation in achieving the MDGs (see Table 1). Access to adequate water and sanitation is critical in the fight against poverty. Engineering plays a fundamental role in providing that access.

Table 1: The Millennium Development Goals and water and sanitation

Millennium Development Goals

Water and Sanitation

1. Eradicate extreme poverty and hunger	↕	↕	1.1 billion people do not have access to safe drinking water. ²⁰ 2.6 billion people do not have access to adequate sanitation, this is roughly two fifths of the world's population. ²⁰
2. Achieve universal primary education	↕	↕	443 million school days are lost each year due to water-related diseases. ²⁰ Only 24.3% of primary schools and 2.8% of high schools have proper toilet facilities in Cambodia. ²²
3. Promote Gender equality and empower women	↕	↕	The average weight of water that women in Africa and Asia carry on their heads is 20kg . ²¹ Women are the predominant fetchers of water in communities in these areas.
4. Reduce child mortality	↕	↕	Diarrhoea accounts for more deaths in children under five years of age than any other cause of death. 90% of diarrhoeal deaths are attributed to poor hygiene, sanitation and unsafe drinking water. ²⁰
5. Improve maternal health	↕	↕	Women usually maintain a full rigor of daily chores, up to and immediately after childbirth, including collecting water under often arduous conditions.
6. Combat HIV/AIDS, malaria and other diseases	↕	↕	Lack of clean water, adequate sanitation and hygiene exposes people with HIV/AIDS to increased risk of infection. Stagnant water increases the risk of malaria and other water borne diseases.
7. Ensure environmental sustainability	↕	↕	Sustainable treatment of human waste is critical to improving environmental management, especially in areas of dense population.
8. Develop a global partnership for development	↕	↕	EWB is in partnership with many local organisations in projects directly related to improving water sanitation



NATIONAL

UN action needed for border row, groups say

BY MEAS SOKCHEA

CIVIL society groups on Monday criticised the government for not appealing to the United Nations for help in its ongoing standoff with Thailand over disputed territory along the border.

Chea Mony, president of the Free Trade Union (FTU), said that if the government had complained to the UN earlier and stuck to their complaint, there would not have been any Cambodians killed over the issue.

At least three Cambodian soldiers are dead after clashes last week with Thai troops on the border near Preah Vihear temple.

"Despite the fact that both sides sustained injuries of a similar magnitude, we are still filled with regret for the loss of our soldiers," he said.

"If the government had used the UN to solve this problem, there would be no dead soldiers," Chea Mony added.

An unknown number of Thai casualties were also inflicted.

Yong Kim Eng, president of the People's Center for Development and Peace, said Monday the government's efforts to resolve the dispute were muddled.

"At one moment, they say they want to complain to the UN. At the next, they don't," he said.

Early on in the three-month standoff, Cambodia threatened to file a formal complaint with the UN Security Council, but quickly backed down.

Council of Ministers spokesman Phay Siphan said Monday that the UN and several "big countries" had encouraged Cambodia to choose negotiations.

"We have already written to the UN and sent information to Asean and Unesco. If these measures don't work, we will find another way," he said.

Local officials are trying to get rid of Pursat's floating community, but residents say they will simply float further out onto the lake to avoid eviction

Floating village threatened



Young residents of Kampong Luong village in Pursat enjoy the boating life on Monday. RICK WALLEN/VEILA

BY MAY TITTHARA AND ELEA NOR AINGE ROY PURSAT PROVINCE

KAMPONG Luong Village is different from other places. It has no fixed address, it is prone to rapid fluctuations in altitude and it floats upon water. Here the daily sounds are of splashing oars and the smells are a distinct mix of water weed, wet wood and family life - all played out on the surface of the great Tonle Sap.

But this unique commune of 1,000 residents, located just 42km from Pursat town, is steadily moving further from land as it seeks to escape a government decree ordering its closure and forced eviction.

"I would rather die than move," said Ros Sareum, 43, a life-long inhabitant of Kampong Luong.

"We have no businesses to run elsewhere so how can we move? Here ... at least we have fish to feed ourselves," she said.

"If the plan goes through and the authorities come to force me, I will move out to the centre of the lake."

Ros Sareum is not alone in her rebellious plans, and many in the village are preparing to oppose the forced eviction.

"Fishing sustains our life," said 31-year-old Song Lisra. "If we are forced to move, our lives will deteriorate because we don't know how else to earn money other than by fishing."

Krakor district Governor Ly Ponn was unclear as to why the village needed to be dismantled, but said not all of those living there will be moved. Only those living closest to the road during the rainy season,

IF THE PLAN GOES THROUGH... I WILL MOVE OUT TO THE CENTRE OF THE LAKE.

their houses half in and out of the water, needed to leave.

"For the people who live on the lake, we will still allow them to live there. People who live along both sides of the road we will move; we don't know when," he said, adding that only about 250 people

will be subject to eviction.

"Their houses are too small, too old and at risk of floods... Concerning their health, we have provided a clean water tank, but if they choose not to use it, that is their decision," he said.

Despite their reluctance to leave, life is hard for the families at Kampong Luong.

While the village boasts facilities such as a medical center, restaurants, schools, karaoke bars and three places of worship, there is no high school in the area and children are only educated to the fifth grade, leaving class at 11 years old.

Residents - particularly children - regularly fall sick with cold, flu and diarrhoea, as well as more severe illnesses such

as dysentery from contaminated water. Not all families boil the water they collect from the lake, which is used for everyone for cooking, washing and going to the toilet.

Koe Sovanath, chief of Kampong Luong commune, said the mixed population of 50 percent Vietnamese and 50 percent Cambodian has lived peacefully together for years and is united in opposing possible eviction.

"We don't know the details of the government's plan, but if they want them to move, they should provide them business options and farm land," he said.

"I don't know why they are moving them. Maybe they want to protect fish stocks."

Humanitarian Engineering Brief

Design Scope

Design for one household living in a floating house or house boat

The Dara household consists of six people, three adults and three children. Da Dara and his wife, Chantel have three children with their eldest son attending high school and their two younger daughters in primary school. They also take care of Chantel's elderly mother. The family home is moved seasonally with the lake levels.

Design for one household living in a portable land based house

The Sok household consists of five people made up of two adults and three children. Pov Sok and his wife, Makara have three children. Their eldest daughter attends primary school. They also have a three year old son and a six months old baby daughter. The family home is carried across the land according to the height of the lake.

Design for one village

The floating village is made up of 500 families, totaling over 2800 people. 60% are female, and there are more young people than older people. 90% of houses are floating and 10% are stilted or portable land based. Both the floating and portable land based houses move with the lake.



1/ Floating household



2/ Portable land based household



3/ Floating village

Design for one floating school

The floating school is for primary students who attend for half the day from 7:00 to 11:00 am. The school is situated in the floating village to ensure access to education for younger children as many cannot travel (paddle) to the stilted school. Approximately 50 students attend the floating primary school. A private latrine facility is available at school that inputs pathogens directly into the environment.

Design for one stilted school

The school is built on permanent, concrete stilts, and is accessible by road in the dry season and by boat in the wet season. There are four buildings in the school: two buildings are for the primary school (grades 1-6), one for administration, storage and vocational training and one for the newly established high school classes. There are approximately 500 students attending the school.

Students who live in homes situated inland from the stilted school travel by walking 1km, or by taking a "moto-dup" (motorcycle) for US \$0.12.

Students who live on the lake take the family paddle boat to school when possible. However, the boat is often needed for other purposes like fishing. The school has two motorboats that transport people to and from the school. One is for teachers and one is for students. The student boat operates during the wet season from the highway to the school. However, there is no student boat that assist students living lakeside.

Two latrines are available at the school. They empty straight into the water during wet season. During the dry season, the toilets are not in use as the exit chute is situated mid-air. Students typically use surrounding bushes during the dry season.



1/ Floating school



3/ Permanent stilted school

Theme / Waste Management

Context

There is virtually no waste management in Cambodia outside major cities, and the floating villages of the Tonle Sap are no exception. Most forms of industrial and urban pollution end up in rivers and wetlands. In floating villages, all solid and liquid wastes are disposed of in the lake. Oil spills from boats are a constant environmental problem. Chemicals and pesticides also end up in the lake, where some are trapped in plants.

Recent surveys with the community indicate that they are concerned about dumping waste directly into the lake. However, they see no alternative solution to the issue.¹⁸

Suggested Design Projects

Live & Learn is interested in waste management systems that integrate waste reduction, re-use and recycling strategies with livelihood and energy generation.

EWB and Live & Learn invite you to consider one or more of the following design projects:

- Alternative packaging materials to plastics and foam
- Integrated waste management systems
- Composting system for household waste
- Waste collection devices
- Waste reduction and management education
- Recycling systems
- Re-use opportunities from waste



1/ Waste goes directly into the Tonle Sap, Kampong Luong



2/ Chemicals on the Tonle Sap, Kampong Luong



3/ Rubbish goes directly into the water, Chhnok Trou



Theme / Housing and Built Infrastructure

Context

In Cambodia, a mean number of 5.1 people live in each household¹⁹. In rural areas, housing construction can range from wood with cement stilts to bamboo and palm leaves depending on the family's income⁴.

In the unique hydrological system of the Tonle Sap region, communities have adopted different solutions to living on and around the water. Many villages remain close to the shore, moving several kilometres seasonally as the Tonle Sap expands and contracts.

Typically, there are three categories of buildings: stilted, portable land based and floating.

Stilted buildings are permanent and are typically raised up to five metres from the ground. During the wet season, the stilted buildings are surrounded by water and during the dry season, they become land based.

Portable land based buildings are typically raised on stilts one foot above the ground and are carried across the land as the lake water level rises and falls.

Floating buildings and boats are permanently on the water and move seasonally with the height of the lake. Buoyancy devices typically used for floating buildings consist of bamboo sticks, empty steel drums or plastic barrels.

Surprising arrays of buildings are present in floating villages including stores, repair shops, schools, churches and even gas stations. However, the construction quality varies widely and many of the poorer households live in small houses vulnerable to the frequent storms.



1/ Portable land based houses, Kampong Luong



2/ Floating house boat, Kampong Luong



3/ Permanent stilted buildings, Kampong Luong





Suggested Design Projects

Climate change and its associated increase in violent storms is a particular concern in the near future. Also, as glaciers melt in the Himalayas, water levels in the Mekong River, and consequently in the Tonle Sap, could rise.

An opportunity exists to develop appropriate infrastructure that takes into consideration the social, environment, economics and safety aspects of communities living on the Tonle Sap Lake and River.

EWB and Live & Learn invite you to consider one or more of the following design projects:

- Floating village design
- Portable land based housing design allowing greater ease in mobility
- Floating bridges
- Buoyancy devices
- Disability access for houses
- Interior design of housing including locally produced furniture and fittings
- Eco-housing tourism
- Human rights policies and education, particularly for landless and marginalised communities living on the Tonle Sap
- Temporary housing for disaster relief

- Sustainable "climate proof" floating housing design and construction management
- Passive solar floating building design
- Cooling options for aquatic housing



4/ Floating homes for families and pets ,
Kampong Luong



5/ Floating buildings Kampong Luong



6/ Buoyancy devices, Kampong Luong

Theme / Water and Sanitation

Context

In Cambodia, water-borne diseases like typhoid fever, hepatitis and diarrhoea are a major cause of morbidity and mortality.⁸ However, only 34% of Cambodians have access to safe drinking water.¹

Sanitation is also a serious issue. Only 16% of Cambodians have access to appropriate sanitation.¹ These numbers can drop below 10% in the provinces surrounding the Tonle Sap.¹ Few people use latrines or have access to improved drinking water sources. This contributes to the high prevalence of water-related diseases.¹

In the floating communities of the Tonle Sap,

these issues pose even more of a problem. The lake is the source of water for many activities such as bathing, drinking, washing and irrigation. Unfortunately, all liquid and solid waste is also discharged into the lake, including open sewage, solid waste, toxic pesticides and chemicals.¹

Bacterial levels around floating houses are up to ten times higher than in surrounding lake areas.¹⁸ This indicates the high environmental and direct health impact due to the lack of sanitation and direct waste treatment systems.¹⁸ Dilution through flooding and rain in the wet season tends to limit these impacts. However, in the dry season

the lake reduces its size significantly. During this period, the health and environmental problems become more severe. This is exacerbated by population growth through seasonal and long term migration.¹⁸

Sanitation should consider the needs of all community members. Lack of sanitation in schools, particularly high schools, is considered to be a major cause of girls dropping out of schools due to an inability to safely and privately manage their sanitation needs including menstrual hygiene.



1/ Water for bathing and playing, Chhnok Trou



2/ Stilted latrine



3/ Floating latrine, Kampong Luong



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Suggested Design Projects

Disability access and an ageing population with limited mobility is also a consideration in sanitation.

The situation on the Tonle Sap means that access to safe water sources, sanitation and waste management are more interconnected than in other parts of Cambodia. Integrated designs and management systems are essential. However, the floating context makes it difficult to apply directly many of the solutions used on firm ground. A classic problem is the design of a latrine for a floating house. At the moment, there are no simple solutions to this problem.

The communities in this unique environment, require innovative water and sanitation solutions that are culturally appropriate and economically accessible.

EWB and Live & Learn invite you to consider one or more of the following design projects:

- Menstrual hygiene management
- Low cost water pumping devices
- Passive water distribution systems
- Simple water quality testing kits
- Incentives from sanitation (carbon credits for methane capture)
- Temporary water storage or sanitation system for disaster relief

- Water supply, storage and treatment systems
- Floating latrines
- Portable land based building latrines
- Stilted school latrines
- Health education



4/ 1000 Riel for treated water 20L refill, Chhnok Trou



5/ Water harvesting, Kampong Luong



6/ UV water treatment, Chhnok Trou



7/ Water treatment basins, Chhnok Trou

Theme / Education and Information Technology

Context

88% of the Cambodian population is covered by a mobile phone network.³ In 2001, Cambodia had 31,000 wired phones and 250,000 mobile phones, a ratio of about one to eight - the "world's highest mobile share".³ In 2006, there were only 0.3 computers per 100 people in Cambodia.³ Only 0.3% of Cambodian's use the internet (with only 0.01% of the population subscribed to broadband).³ However, 43% of households in Cambodia have a television set, a majority of them powered by 12 V car batteries.³

With 90% of Cambodians living in rural areas,² providing access to communication technologies

proves to be an enormous challenge. This is complicated by the relatively high prices of access to information technologies. Cambodians love karaoke though, and you will find karaoke machines in surprisingly remote places. Karaoke can be a powerful education tool when used to convey education messages about human rights, health and environmental issues.

In the floating villages of the Tonle Sap, some access to information technologies exists due to the creativity of the people living in these communities. However, it is made difficult by the floating context and many people cannot afford access.

Suggested Design Projects

Information, communication and technology provide opportunities to develop innovative solutions to the problems encountered by communities living on and around the Tonle Sap. EWB and Live & Learn invite you to consider one or more of the following design projects:

- Mobile phones for education/training tool
- Hardware for interactive educational games
- Software for educational games relating to human rights, health and environmental issues
- Severe weather warning system



1/ Satellite , Chhnok Trou



2/ Televisions are common in Cambodia, Kampong Luong



3/ Floating mobile phone shop, Kampong Luong



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Brief material sourced from resources of the EWB Challenge 2009 (note that references may contain additional material not referred to in brief due to shortened length of resource).