Case Study at Monako Gama

Improved Sanitation for a low income community considering Climate Change

Prepared and published by :
NIVA – Norwegian Insitute for Water Research, University of Moratuwa, UN HABITAT, Negombo Municipal Council

Funded by:
Nordic Climate Facility (NCF), Nordic Climate Facility (NCF) is financed by the Nordic Development Fund (NDF) and implemented jointly with the Nordic Environment Finance Corporation (NEFCO

CCSL - Climate Resilient Action Plans for costal urban areas, Sri Lanka

This book is published as a part of the *Climate resilient action plans for coastal urban areas of Sri Lanka (CCSL).*

For more information, please contact:

Professor P.K.S. Mahanama (FITPSL)
Dean, Faculty of Architecture, University of Moratuwa, Sri Lanka
Email: mahanama@uom.lk
Tel: +94112640201

Mr. Laxman Perera
UN-HABITAT Programme Manager for Sri Lanka, UN-HABITAT Sri Lanka, Colombo 07, Sri Lanka
Email: laxman@unhabitat.lk
Tel: +94112580691

Dr.Isabel Siefert
Project Manager, Norweigin Institutute Water Research (NIVA), Gaustadalleen, Norway
Email: ise@niva.no
Tel: +47 98 215 414

Prepared and published by:
Norweigin Institutute Water Research (NIVA), Gaustadalleen, Norway

Funded by:
Nordic Climate Facility (NCF), Nordic Climate Facility (NCF) is financed by the Nordic Development Fund (NDF) and implemented jointly with the Nordic Environment Finance Corporation (NEFCO)

Norwegian Institute for Water Research | University of Moratuwa | UN-HABITAT FOR A BETTER URBAN FUTURE | Negombo Municipal Council | Batticaloa Municipal Council

PROJECT TEAM

Norwegian Institute of Water Research (NIVA), Norway

Dr.Isabel Siefert	Project Manager (NIVA)
Ms.Line Barkved	Research Scientist (NIVA)
Ms.SiljeHolen	Research Scientist (NIVA)

University of Moratuwa, Faculty of Architecture, Sri Lanka

Prof. P.K.S. Mahanama	Team Leader Dean, Faculty of Architecture, UoM
Dr. Fahmy Ismail	Consultant National technical advisor, UN Habitat
Mr.AmilaJayasinghe	Infrastructure Planner Lecturer, Dept. of T&CP, UoM
Ms. Chethika Abenayake	Environmental Planner Lecturer, Dept. of T&CP, UoM
Mr.Chathura De Silva	Junior Consultant (Urban Planner)/ Project secretary
Mr.KasunBandara	Project Associate (Landscape Architecture)
Ms.SuharshaKumarasinghe	Project Officer (Environmental Planning)
Mr.Krishan Stanis Barthelot	Project Officer (Batticalo MC)

UN –Habitat

Mr.Laxman Perera	Program Manager – UN Habitat

Batticoloa Municipal Council, Sri Lanka

Mr. K. Sivanathan	Commissioner Batticaloa Municipal Council (BMC)

Table of Contents

Table of Figures

Case Study Negombo: Sanitation at Monako Gama

1 Introduction

The community at Monako Gama was established with 88 houses for Kurusawatte fisher families in the years 2002/2003. The total project costs were 10.12 mio. Rs. The project partnership consisted of:

- Habitat for Humanity Sri Lanka
- World Vision Lanka
- Homeowners

The houses are located on the water front of the peninsula in the Negombo lagoon. The houses are mainly aligned along four access ways (see Figure 1).

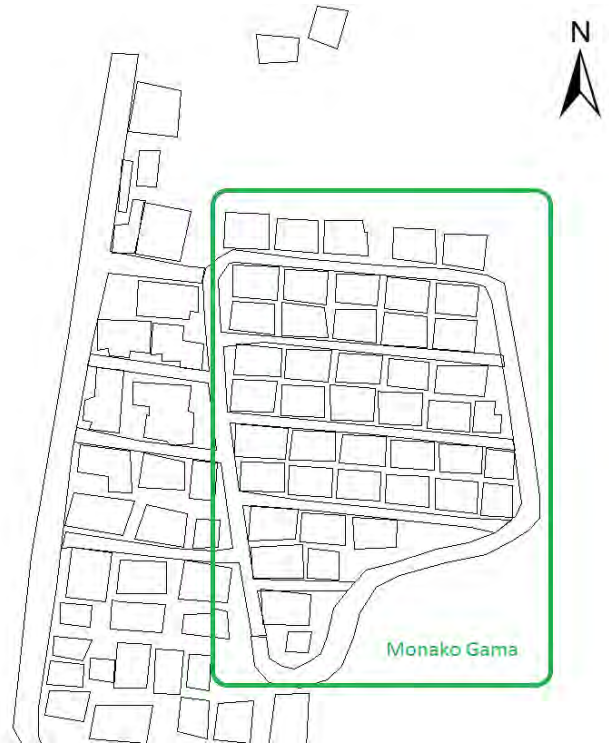

Figure 1: Housing project Monako Gama

2 Current situation

Monako Gama has a very densely built structure with only limited space for private gardens etc. (see Figure 2).

Figure 2: Typical street views of Monako Gama

All houses are equipped with their own toilet. The toilets are simple squat type toilets with a brick structure and roof. The toilets have a small opening to allow ventilation. They are commonly attached to the houses (Figure 3).

Figure 3: Individual toilets attached to all houses

These toilets are connected to a total of 18 septic tanks. The septic tanks are located in the gardens of the houses (Figure 4). They are equipped with an opening for the gully suckers. Due to their location in the gardens and the very narrow streets in this community, the gully suckers cannot easily access the septic tanks.

Figure 4: Septic tanks in gardens with opening for gully suckers

Meanwhile, all houses are connected to the public water network (see picture). Until 2011, a standard fee was paid for water supply. Successively, water flow meters have been installed at all households, leading to individual invoicing according to the consumption rate. Water is used for all household purposes and for flushing the toilets. According to residents, a bucket is used for flushing the toilets.

Only the toilets are connected to the septic tanks. Kitchen wastewater and water used for washing (often referred to as grey water) is discharged from the houses open drainage to the lagoon. These open drains are located along the access roads in the community (see Figure 5).

Figure 5: Open drainage of grey water at Monako Gama

All open drains are collected along the lagoon and discharged to the lagoon without further treatment. Additional to the grey water from households, storm water is drained out of the community though the open drains. Especially in the dry season, debris and particles can accumulate in the open drains. Plastics can also accumulate in the drains. A tubing ends on the embankment of the lagoon, the water runs over the grass surface down to the lagoon (see picture).

This leads to further pollution of the lagoon, what is already a problem in the Negombo Area (personal communication, Dec. 2011).

Originally 11 septic tanks were established for the community. Up to 10 houses were connected to the septic tank. Unfortunately, the sanitary situation was not satisfactory at Monaco Gama. This is attributed to the fact, that the gully suckers don't have easy access to the septic tanks and the tanks fill up too fast.

The city of Negombo currently has three gully suckers in operation for the entire city. Two gully suckers have a capacity of 2,5 m^3, the third gully sucker has a capacity of 7,5 m^3 (personal communication, Dec. 2011).

Therefore, the residents of Monako Gama have found ways to handle overflowing septic tanks. A number of individual tanks have been constructed for houses. Furthermore, septic tanks were equipped with overflows leading to drainage of the untreated wastewater, if the septic tanks are overfilled. The overflows are connected to the open drains in the streets. This poses a potential risk to the community. Health problems are not uncommon if untreated wastewater is discharged in open drains within a community. Furthermore, pollution of the lagoon is caused by draining untreated wastewater.

With regard to climate change, the sanitation issues are at risk of deteriorating. Therefore, aim of this project was to identify a possible solution for the sanitation at Monako Gama.

3 Survey

Within this project a survey has been conducted at Monako Gama. A total number of 30 houses in the northern part of the community were selected for the survey. The inhabitants of the houses indicated in the map Figure 6 were therefore interviewed. Furthermore, the relevant septic tanks with the houses that are connected to the septic tanks are shown. Additionally to the 30 houses, the current situation of all septic tanks was investigated in this survey (see Figure 7).

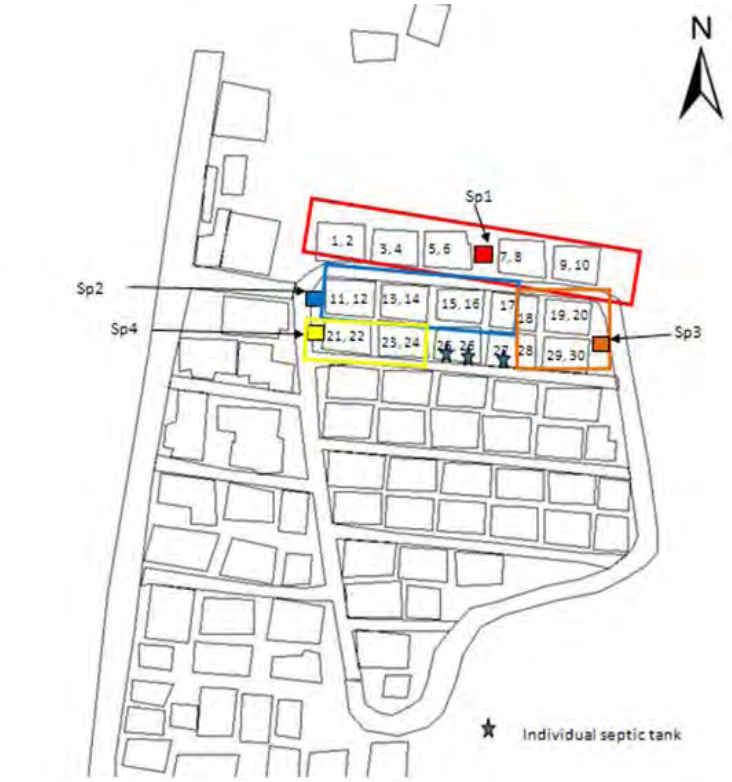

Figure 6: Houses in Monako Gama selected for the survey conducted

None of the houses was ever flooded by the lagoon before. Usually, the water level of the lagoon is about 1 m below the ground level of the houses.

Only one household is growing plants in the garden. This is most likely attributed to the fact, that only two out of 30 houses have a garden of 10 and 20 ft. respectively. The other houses do not have a garden at all.

The average monthly household income varied between 10.000 and 45.000 Rs with an average of 21.000 Rs.

About half of the households interviewed were satisfied with their current sanitation situation. Among those who made suggestions, the most common was the construction of individual septic tanks with overflows to the lagoon. In order to improve the existing situation, eight house owners built individual septic tanks just for their house. Two thirds of the existing septic tanks have been modified with overflow tubing, thus untreated wastewater is drained via the open channels into the lagoon.

Usually, the gully sucker comes when complaints are made. Between 50 and 100 Rs are paid to the gully sucker.

The toilets of all households are only used by the families living in the house. The houses investigated in the survey are inhabited between one to seven adults and none to four children. The average values are three adults plus two children per household. In each house an average of four to five persons is living. All but three households consist of 4-6 persons including children.

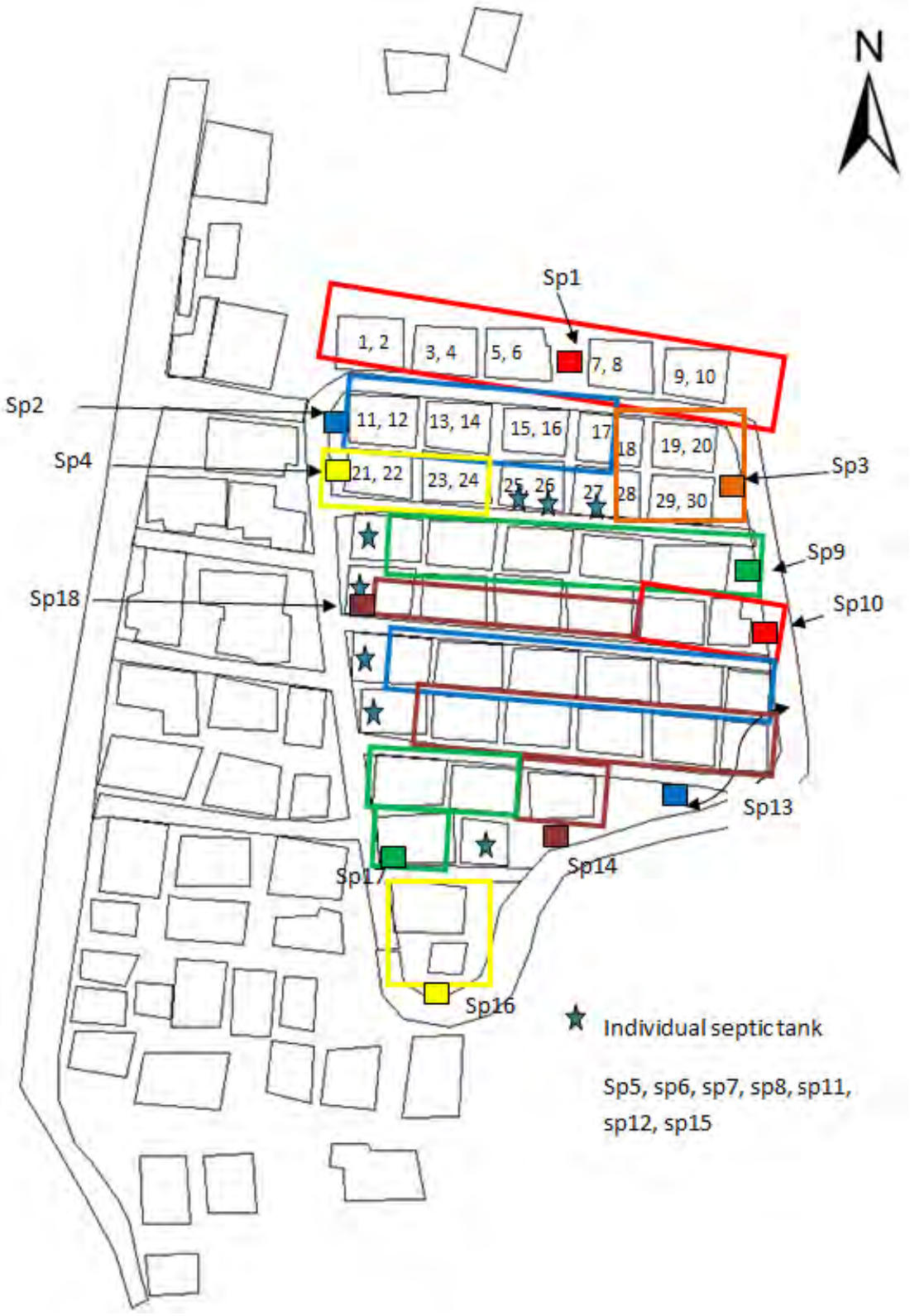

Figure 7: Septic tank situation at Monako Gama

4 Suggested solution

The main problem at Monako Gama is the insufficient wastewater removal from the septic tanks by the gully suckers. The currently practiced drainage of untreated wastewater from the septic tanks to the lagoon in open drains is viewed as very problematic. It poses a potential health risk to the community and leads to further pollution of the lagoon. Both issues are critical for this community of fishermen.

4.1 Dry toilets

Therefore, a solution is proposed, which reduces that wastewater volumes. The central structure of the septic tanks with up to 10 houses connected to one septic tank requires significant amounts of water for flushing. This can be reduced, if individual solutions are implemented.

Dry toilets have been introduced all over the world in very different types. They can easily be adapted to cultural, local and climatic condition. The basic idea is the separation of liquid and solid phase of the excreta. This enables treatment and storage of excreta on site. In the absence of moisture, organisms cannot grow and as such, smells are minimized and pathogens are destroyed. No water for flushing is needed, thus saving drinking water and reducing wastewater that has to be treated.

Dry toilets are built on top of the ground and therefore can be utilised in regions where ground waters are close to the surface as in Monako Gama. Dry toilets do not require water for flushing but water for personal hygiene – as it is common in Sri Lanka – can be used. The existing toilets at each household can be transformed into a dry toilet.

In Figure 8 a model of a dry toilet is presented. A base is constructed out of concrete bricks or other water proof material. At Monako Gama, urine will not be separately collected but drained to the existing septic tanks together with wash water for personal hygiene.

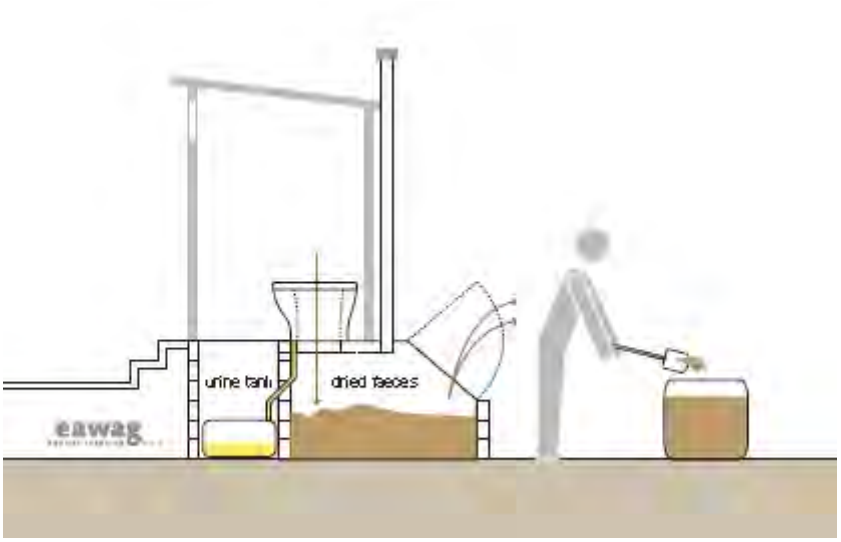

Figure 8: Schematic drawing of the dry toilet with composting (EAWAG)

Separation of liquids from the solid excrement makes handling of excrement easier and reduces the load derived from excreta by e.g. reducing the volume of excreta, reducing the odor problems and decreasing the runoffs of pathogens and nutrients (e.g. nitrates) to soil, ground water and surface

waters. Solid excrement is easier to handle if it is dry and pathogens can die rapidly than in wet mixture of urine and solid feces.

Urine is a very good fertilizer, since most nutrients are in the urine compared to feces. This led to the development of urine separation toilets. At Monako Gama, urine will be diluted with water for personal hygiene and will get in contact with feces in the toilet chamber. This can lead to contamination of urine with germs. Furthermore, at Monako Gama also most no gardening takes place, where fertilizer is needed. Therefore, the (re-)use of water from the septic tanks is not recommended!

4.2 Mode of operation

Solids and liquids are separated in the dry toilets. Liquids are urine and the water used for personal hygiene. The liquids are drained out of the toilet by the existing tubing to the existing septic tanks. Solids are treated in the toilet itself; therefore no water for flushing solids into the septic tanks is needed. This is especially interesting for Monako Gama where houses and septic tanks can be quite far apart.

At Monako Gama the existing structure concerning toilets, pipes and septic tanks should be used. Within the toilet, the toilet chamber will be build. The solid feces are collected in the toilet chamber. Water is drained and dry material is added for dehydration of the material. The toilet chamber is about 1,5 ft high. The roof of the toilet has to be elevated by the same height of the toilet chamber. The toilet chamber is open to one side, facilitating removal of fresh feces to the storage box. Therefore a hole has to be made into the existing toilet wall, unless the storage box is located in front of the toilet. The storage box is outside the toilet. Here feces can compost. Once a week, the fresh feces in the toilet chamber have to be moved to the storage box. This is important for dehydration of the feces, to assure proper composting. By composting, the volume of the feces can significantly be reduced. Furthermore, dried feces are much less problematic than wet/fresh feces, from a hygienic point of view. A ventilation pipe has to be installed in the new toilet of storage box. This helps the composting process and avoids bad smells. Hygienic aspects have to be considered when working with feces!

The existing tubing draining wastewater to the septic tanks will still be used in the new dry toilet. Purpose of the dry toilet it the separation of liquids and solids. If water is not draining from the toilet chamber, the effluent might be clogged. The clogging has to be removed as soon as possible.

When the storage box is filled with feces, the content has to be collected by the gully sucker and taken to the Negombo wastewater treatment plant. There they have to be placed in the sludge drying beds, where they should be kept for at least one year. In the rainy season, the sludge drying beds should be covered. The toilet waste can then be used as fertilizer or soil enrichment. Completed compost is dark, relatively dry, light and smells like soil. Even though no pathogens are assumed to be in the compost it should be handled carefully (e.g. use of gloves, washing hands and two months withdrawal period between spreading the compost and harvest). Children should be kept away from composting sites, because pathogens in the compost can spread easily through their (children's) hands and clothes to others.

Good substrate can be made by mixing compost with sand and clay in the ratio 1:1:1. Different amounts of compost soil should be apportioned to different plants, and it needs to be noticed that not all plants prefer compost soil which can have high pH value. Compost soil is good for pumpkins, tomatoes, cabbages, corn, fruit trees and currants, cherry and lilacs. E.g. for potato compost soil is too alkaline.

The septic tanks still have to be emptied by the gully suckers when they are filled. But, since no more water for flushing is used and no solids enter the septic tanks any longer, the septic tanks will fill up much slower, leading to much longer intervals for emptying the septic tanks.

If the toilets are painted from the inside, the best color is blue since it is said to be unattractive to flies. All windows and other openings should be protected with fly screens.

4.3 Separation of liquids

For the separation of liquids modifications of the current toilet floor have to be made. This has to be done before the toilet chamber is built. The floor of the toilet has to be leveled to a flat surface with an inclination opposite the storage box. The ceramics of the toilet have to be removed and the drain in the middle of the toilet floor hast to be sealed. In the lowest corner (inclination into this direction, opposite storage box), the existing tubing to the septic tank has to be connected. In order to have a proper solid/liquid separation, a small weir (appr. 1 inch high) has to be installed. The weir can be made out of hard plastic of metal (see Figure 9).

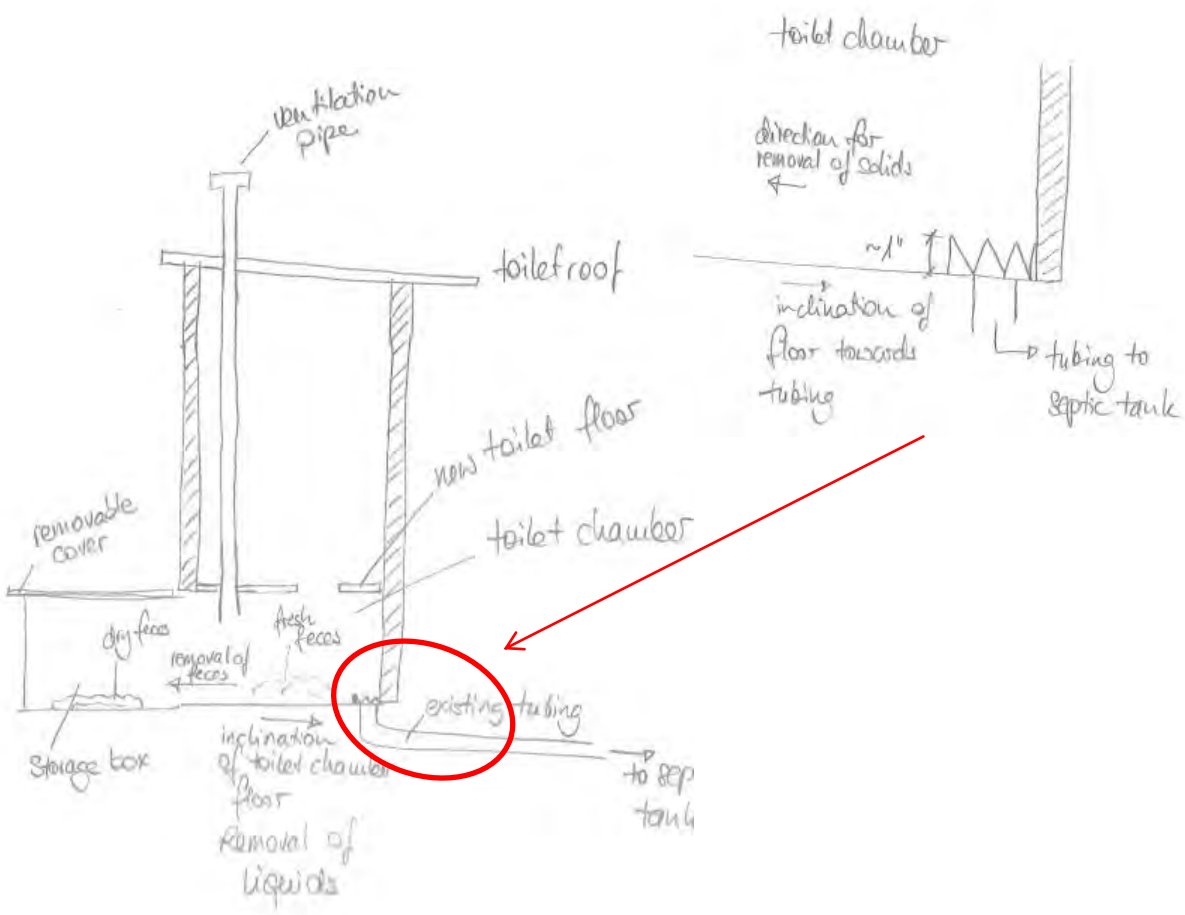

Figure 9: Installation of liquid drain (Overview and Detail).

4.4 Calculation dimensions of the dry toilet

A family of 6 will produce approximately 500L of feces in approximately six months (EAWAG). For design purposes it is recommended to assume that one person will require almost 100L of feces storage space every six months. The vaults should be slightly oversized to account for airflow, visitors and the non-even distribution of feces in the chamber.

4.5 Toilet chamber

The toilet chamber will be constructed in the existing structure. First the location of the storage box has to be decided. The existing toilet wall has to be removed in the lowest part to facilitate feces removal from toilet chamber to storage tank. On two sides of the walls new brick walls have to be built to support the new toilet floor (see Figure 10). The height of the walls should be approximately 1,5 ft in order to provide about 500 L storage capacity in the toilet chamber. This is enough space for a family to use the toilet about six months. The capacity of the dry toilets strongly depends on the use.

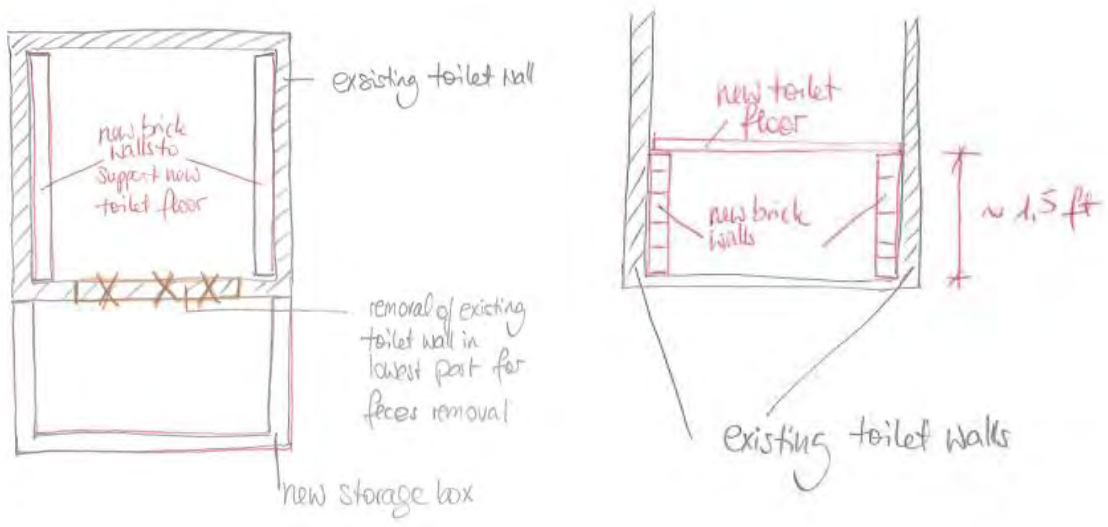

Figure 10: Construction of the toilet chamber in footprint and cross section

4.6 Construction of the new toilet floor

In the toilet, a new, elevated floor has to be constructed on the toilet chamber. It can be made out of different materials such as a wooden plate, metal plate or concrete. It has to be strong enough to support an adult person. The dimensions of the new toilet floor are equivalent to the area of the old toilet floor. The area of the toilets of the different houses varies.

The explanation how to make the concrete floor is as follows:

The first step is to make a rectangular concrete slab. The concrete slab is made with a mixture of cement and good quality river sand with some wire reinforcing. The mould for the concrete slab is made from bricks laid on levelled ground, covered with a plastic sheet in order to prevent the concrete from sticking to the ground (see Figure 11). Holes for the squat hole, and vent pipe if required, are made by inserting moulds within the brick mould. Wires for reinforcement have to be included and should be 3 - 4mm thick. They should be located in the middle of the concrete slab. 4 steel handles can be added if required.

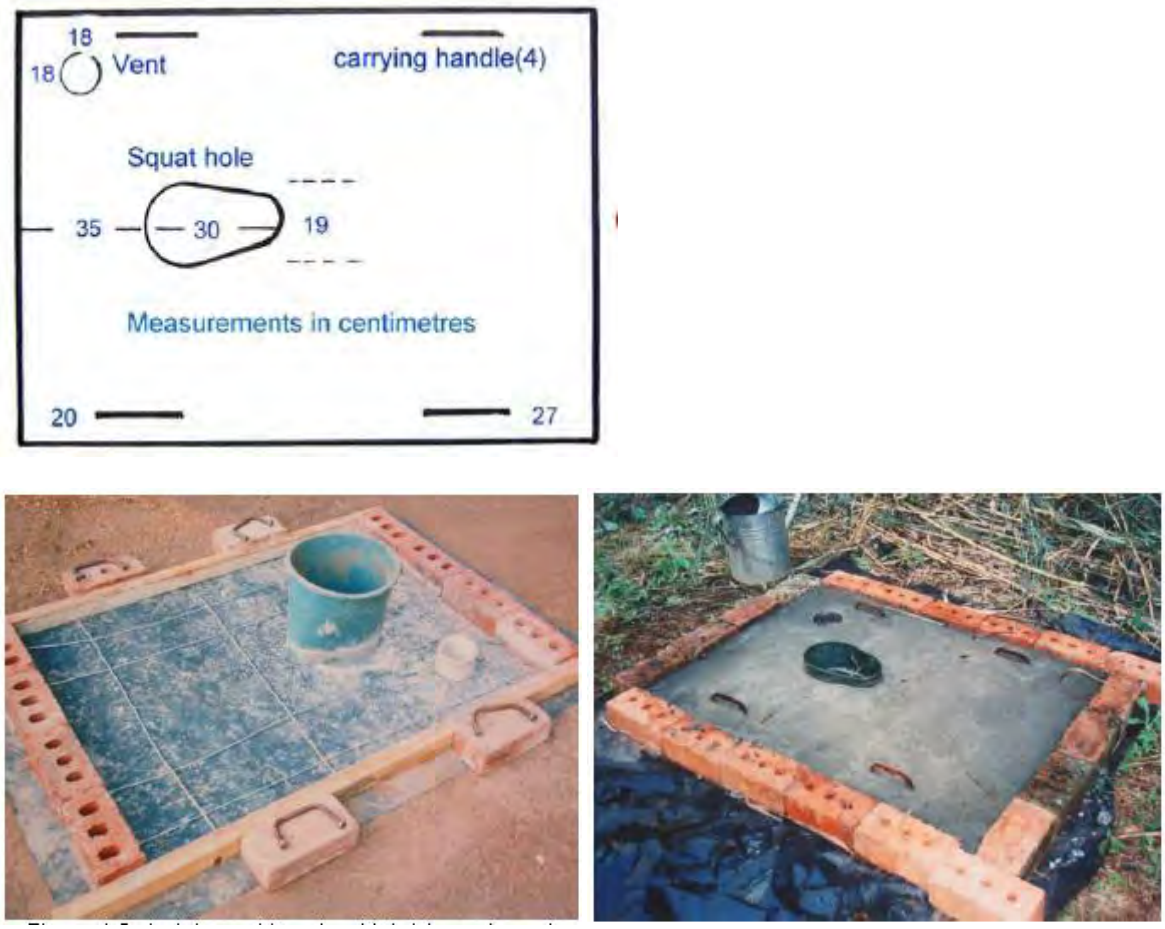

Figure 11: Different stages when toilet floor is made (Fotos Peter Morgan)

Figure 11 shows an example of a slab mould made of bricks. Finally the slab is smoothed down flat with a steel float and left to cure for 7 – 10 days.

4.7 Storage Box

The storage box is outside the toilet. Here feces can compost. The storage box has to be opened once a week and for removal of the feces when the box is full. The lid of the storage box has to be removable easily. Once a week, the fresh feces in the toilet chamber have to be removed to the storage chamber.

When the storage box is full, it has to be emptied by the gully sucker. When storage boxes are emptied by the gully sucker, the material should be handled carefully in order not to pollute the immediate surroundings of the houses. Profound cleaning is necessary after working with the toilet wastes. The storage box is best placed behind the toilet in order to keep entrance to the toilet clean. If this is not possible, the storage box should be located on one of the sides of the toilet. Only as a last possibility, the storage box can be placed in the entrance, front part of the toilet. This way, persons entering the toilet will have to step on the storage box.

Unfortunately, only at 7 of the 30 houses that were investigated in the survey, there is enough space available on the sides of the existing toilets for the storage box. At these houses the storage box will

have to be located in front of the toilet as described above. This is not the best solution and should only be used if it is the only solution.

The storage box consists of three brick walls and a cover. They have the same height as the toilet chamber. The walls of the storage box are made out of bricks. The walls should be sealed afterwards in order to be water proof. The inclination of the floor should be in the direction of the toilet chamber. The existing toilet wall between toilet chamber and storage box has to be removed, in order to facilitate the removal of feces from toilet chamber to the storage box.

The cover of the storage box has to be removable, since fresh feces have to be moved to the storage box once a week. This is important for dehydration of the feces, to assure proper composting. With a pitchfork or broom, the feces should be moved. Avoid touching fresh feces by hand. Wash hands after working. Clean all tools used profoundly. Children should not be present. The cover can be made of hard plastic, wood or metal plates.

If the storage box is installed in front of the toilet, the cover of the storage box has to be strong enough to support a person using the toilet!

4.8 Orientation of dry toilet

Aim of the dry toilet is the composting of feces. In order to achieve this, water is separated from the feces by drainage to the septic tanks, addition of dry matter and ventilation for further drying of the feces. Of course, drying through ventilation works best, if maximum temperatures are reached in the storage box. Therefore, the storage box should be constructed with dark materials or painted. Furthermore, orientation towards the sun - where possible - increases the drying process (see Figure 12).

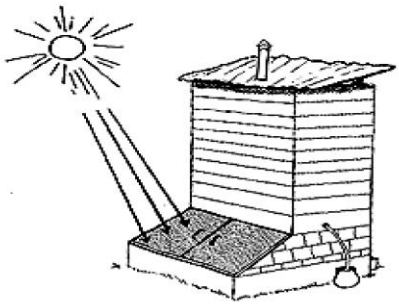

Figure 12: Optimal orientation of the dry toilet (Rotaria, Peru).

4.9 The composting process

Composting is a biological process where the microbe community (containing many species) decomposes organic material. In the process mould (soil containing 20-40% organic material), water vapor, inorganic salts, carbon dioxide (CO_2) and nutrient rich liquid forms in the process. A lot of heat energy is also formed, which (temperature rise) in a functional process is of essential character. In composting process the waste compacts and dries in the process remarkably so that the volume of compost mould is ca. 10-20 percent of original volume.

By composting toilet waste, the nutrients it contains return back to nature's cycle. Utilization of these nutrients is of significant financial benefit since they can substitute artificial fertilizers. Composted toilet waste can be utilized as soil enrichment material e.g. for planting trees and by doing so decrease increasing erosion in arid areas.

Composting latrine waste works the same way as composting other organic matter. Oxygen is needed in the process for the work of the microbes. Mixing material and turning the compost ensure needed lightness. Moisture can be controlled by draining water, adding dry material (bulking material) and ventilation. Absolutely safe hygienic products cannot be achieved only by composting. Composting is though best biological waste treatment method in terms of hygiene and it is easy apply to conditions where financially there are no possibilities to use other methods.

A good carbon - nitrogen ratio for composting of latrine waste is between 1:20 and 35:1. Ratio for carbon- nitrogen is 5:1 in human excrement. To balance the ratio carbonic dry mixing material e.g. kitchen waste, woodchip or leaf litter or pure soil if nothing else is available must be added. Carbonic material binds also excess moisture and therefore compost stays light.

4.10 Dry material

Dry material is needed for the stabilization and dehydration of the feces. Dry material has to be added after each toilet usage. Roughly about one third of volume of the feces has to be added as dry matter. As dry matter leaves, sawdust, shaving, fine straw, rice husk, ash (can be mixed with sand), dry kitchen waste, soil or lime can be used. Ash (especially wood ash) is known to avoid flies and mosquitos in the dry toilet. The dry material should be more lumpy than thready; thready, knotty materials are difficult to handle when storage box has to be emptied. Therefore e.g. coconut fiber is not a good dry matter.

The dry matter should be stored in a cup or bucket within the toilet for easy use after each defecation (see Figure 13).

Figure 13: Adding of dry material after toilet use. Dry material is stored in bucket with plastic cup next to toilet (Rotaria, Peru).

No more water than necessary for personal hygiene should be added to the dry toilet. The dry matter should be added after using water for personal hygiene.

It is wise to put some humus or leaves on the base of the toilet chamber when it is empty (after moving feces to the storage chamber) to avoid sticking of fresh feces and to help start the composting process off.

4.11 Ventilation pipe

The roof of the toilet has to be elevated by the same height that the floor is lifted. A ventilation pipe is needed to avoid smell and for dehydration of the feces. Ventilation pipes should be 30 cm from the wall and if possible are straight without bends. If a bend is needed it should be a 45° never a 90° (see Figure 14). The pipes may be placed inside or outside the toilet. The parts of the pipe that are exposed to the sun should be painted black to improve ventilation and to protect the PVC. The top of the ventilation pipe should be protected from rain and vectors with a cover (or T) and mosquito screen.

Figure 14: Ventilation pipe with 45° bend, mosquito screen and T-tubing (Rotaria, Peru).

4.12 Fly trap

It is recommended to use a flie trap. They consist of a 2.0 L plastic bottle with the opening down as shown in Figure 15. This bottle is placed in the wall with the bottom toward the light, for example in the top part of the storage box. In this way insects that can enter the toilet are trapped.

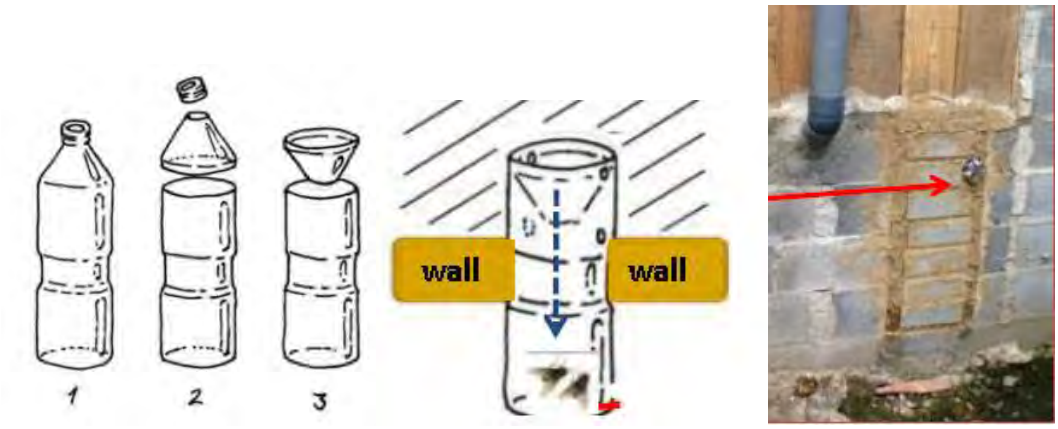

Figure 15: Construction of a fly trap (Rotaria, Peru).

4.13 Before installing new sanitation concept

Due to normal use of the septic tanks primary sludge settles on the bottom. Since the gully suckers usually emptied the septic tanks only partly, it has to be assumed, that considerable amounts of sludge have accumulated in the septic tanks. This accumulation of sludge further reduces the available volume in the septic tanks what worsens the problems at Monaco Gama.

Before implementing a new sanitation system, the existing septic tanks have to be emptied. Therefore a high-pressure cleaner is necessary. If not available, the tanks have to be cleaned by hand. Since unaerated wastewater in septic tanks can produce partly toxic gases safety measures such as good aeration and gas detectors have to be used. It is important to remove the sludge in order to have the entire tanks volume available. Futhermore, mixing of the accumulated sludge and the washwater with yellow water that will be collected in the future should be avoided due to hygienic aspects.

4.14 Instructions for use of dry toilets

The following instructions should be remembered when using a dry toilet:

- Add dry matter after each usage. A cup or bucket with dry matter should be place in the toilet.
- Make sure only minimum amounts of water get in the toilet chamber.
- If the contents of the toilet are wet, add more dry matter.
- If the toilet smells bad or flies are entering the toilet, add more dry matter, and make sure the vent pipe is clear.
- Do not put garbage to the waste (e.g. diapers, sanitary pads or other plastics).
- Provide a place for washing hands.
- If the pile builds up too high, use a stick or manure fork to push it back down.
- Clean the toilet on regular basis and make sure that everything is functioning.
- Fresh feces have to be moved from the toilet chamber to the storage box once a week.
- Remember to use gloves and shoes and wash your hands when handling toilet waste.
- It is very important for parents to teach their offspring adequate utilization and maintenance of cleanliness of latrines. A special attention is to be paid on hand hygiene. Possibility to wash hands after use should be organized.

- When the storage box is full, the gully sucker has to transport the content to the sludge drying beds at Negombo wastewater treatment plant
- The feces should decompose in the sludge drying beds at Negombo wastewater treatment plant for a full year before they can be used for soil enrichment. The level of decomposition has to be checked if further compost time is needed.
- Urine and water for personal hygiene is still collected in the existing septic tanks. But, no water for flushing solids into the septic tanks is needed any longer. Therefore, the wastewater volume in the septic tanks is much smaller – leading to much longer intervals for the gully sucker to empty the septic tanks.

4.15 Remark

Due to the high density of Monako Gama, implementation of dry toilets will lead to issues concerning the necessary handling of feces and urine. Odor problems also cannot be ruled out. Furthermore, gully suckers will still be needed – but to a significantly lower degree.

Therefore, the implementation of dry toilets cannot be regarded as perfect. Unfortunately, this solution is the only effective low cost solution available for Monako Gama. In addition, it provides a significant advantage compared to the current situation, where untreated wastewater is discharged without treatment via open drains into the lagoon!