

A MODEL OF CLEAN WATER SUPPLY AND IMPROVEMENT OF ENVIRONMENTAL SANITARY CONDITIONS IN RESIDENTIAL CLUSTERS IN THE MEKONG DELTA, VIETNAM

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Abstract

In accordance with Decision 99/TTg dated 9/2/1996 and Decision 173/TTg dated 6/11/2001 of the Prime Minister regarding the construction program of residential clusters (residential flood free areas), these residential areas as constructed would be fully equipped with critical infrastructures and services such as water supply and drainage works, toilets with sanitary appropriateness, etc. to ensure environmental sanitary conditions in the residential clusters. However, the actual surveys done in residential clusters in the Mekong Delta show that many arising problems must be addressed to enable the local communities to have better living conditions and ensure the sanitary conditions and environmental safety.

1 INTRODUCTION

MEKONG DELTA, as an outstanding place of agriculture and aquaculture, holds an important role in ensuring national food security and contributes in a large proportion to the export value of the seafood and rice country. In spite of the fact that the development of infrastructure and social culture still correspond to the potential of the entire region, the living conditions of the people in the region especially in the rural areas are still difficult. One of the main reasons of the above situation lies in the prolonged flooding condition causing huge damage to persons and property, thus creating no fewer difficulties for the life of the people in the region.

2 WATER SUPPLY AND SANITATION IN RESIDENTIAL CLUSTERS IN THE MEKONG DELTA

The survey results show that concentrated water supply stations in the residential clusters are available. However, the quality of the water supply source is unable to control. In addition, the quality of these works is not good due to insufficient capital. Most of the surveyed residential areas have water drainage systems, mainly open systems and the level of design works is not appropriate. As a result, the water is unable to flow as it causes a barrier to the flow of water.

In the residential clusters, there are public toilets available with appropriate sanitary conditions as for septic tanks which have been constructed in compliance with current standards. However, due to long-term habits and lifestyle of the local residents and due to many other factors, the local communities do not use these facilities and utilities [1]. They still keep their habits of urinating into rivers, ditches and on the banks of the rivers and ditches, etc. This is one of key reasons causing pretty serious pollution in these residential areas [2] (Fig. 1, 2).



Fig. 1 – A toilet on a ditch – a common type in rural areas in the Mekong Delta



Fig. 2 – Part of a toilet cum bathroom – the Gao Long Den resettlement area, Dong Thap

Because the local communities still keep their habits of urinating into rivers, on ditch banks, and the water drainage system is unable to flow and these systems are open, they contribute to air pollution, and thus local environmental sanitary conditions are not ensured; the garbage is still discarded to rivers and ditches mainly. As

moving to these resettlement areas, the local communities still keep their habits of raising livestock near their houses and the unhandled waste is poured to the environment and this implicates pollution and causes disturbances to their neighbours. The local surface water is polluted [1]. However, part of local communities uses this water source for their daily activities to save their money. This habit harms their health. A high number of local communities get diseases due to the contaminated water source [2] (Fig. 3, Fig. 4).



Fig. 3 – The garbage dump is flooded



Fig. 4 – A local person takes water for daily use

3 A NEW MODEL OF WATER SUPPLY AND SANITATION IN THE RESIDENTIAL CLUSTERS IN THE MEKONG DELTA

3.1 Model of water supply

Model 1. A simple model of water treatment using the PAC powder (household size)

1. Basic information regarding the model implementation

The basic information includes

- Water source for use: surface water source,
- Range of application: household,
- Handling capacity: 300 litres/day,
- Used tools: plastic container, containing capacity 500 litres/container,
- Used chemicals: PAC powder, sterilization substance of chloramine B,
- Chemical norm: use of (1-3 gram of PAC powder + 1.5 gram of chloramine B)/300 litres of water (in accordance with the guidelines for the use of these two chemicals on the market).

2. Implementation process

In this pilot model, the author performed simultaneously 9 tests with the same used water of 300 litres. However, the dosage of PAC powder and the sterilization substance of chloramine B changed. The time for mixing the chemicals in the water was 10-30 minutes and the time for checking the quality of the test sample was 6-9 hours.

The test containers:

- M1-M3: the dosage of PAC powder changed (1, 2, 3 gram), the chloramine B dosage was the same (1.5 gram), the time of mixing was 10 minutes.
- M4-M6: the dosage of PAC powder changed (1, 2, 3 gram), the chloramine B dosage was the same (1.0 gram), the time of mixing was 20 minutes.
- M7-M9: the dosage of PAC powder changed (1, 2, 3 gram), the chloramine B dosage was the same (0.5 gram), the time of mixing was 30 minutes.
- M10: the control container.

Implementation steps:

- B1: Evenly dissolving the PAC powder in 1 litre of water.
- B2: Evenly mixing the mixture of water and PAC powder in 300 litres of water that needed handling for 10-30 minutes depending on each test sample container.
- B3: Directly stirring and mixing 0.25% chloramine B in the water container (in accordance with the norm for the use of each test container of 0.5-1.5 gram).

3. Analysis parameters:

pH, colour, opaque, TDS, DO, COD, NH_4^+ , nitrate, chloride, total iron and E. coli.

4. Implementation results of the model

The analysis results of the water sample in the test containers and the control container showed that, in general, the water quality after being handled with the PAC powder and sterilized with chloramine B was greatly better. Comparing the test results of the model with the clean water supply standards QCVN 01:2009, most of the parameters appeared to meet the requirements. Only the opaque (the lowest result was 12 mg/l in comparison with the standard of 5mg/l) and the microbiological content (the lowest measurement result was 35 MPN/100ml in comparison with the standard of 0) failed to achieve the required values [3]. The efficiency of handling the content of colour, opaque, BOD, chloride, total iron and E. coli in the test samples is shown in Fig. 5.

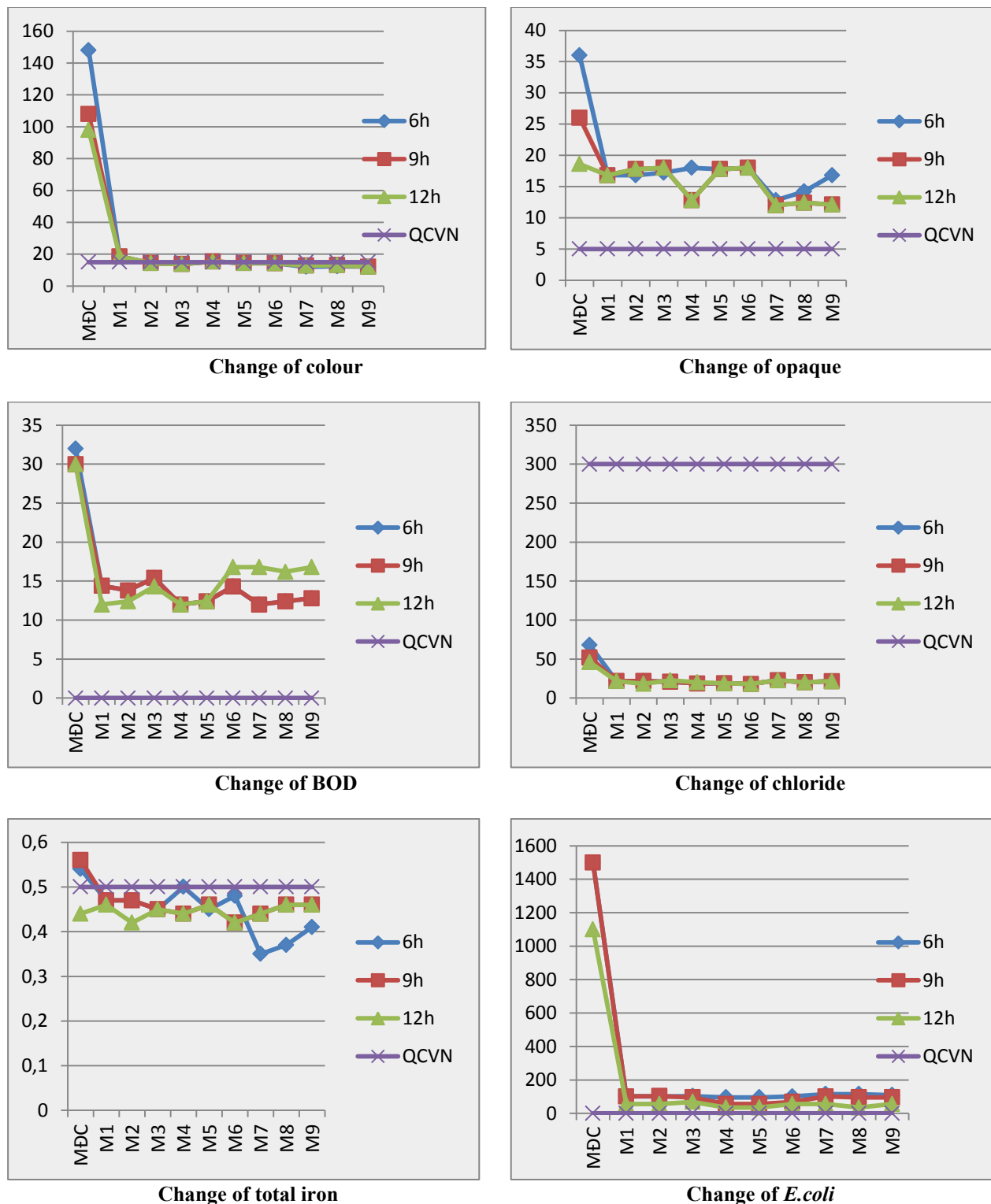


Fig. 5 Efficiency of water treatment

From the charts showing the concentration change of polluted substances (colour, opaque, BOD, chloride, total iron, *E.coli*) in accordance with each test sample and time (6, 9, 12 hours), the following conclusions may be made:

- The test results of the samples M1-M9 in accordance with 3 different durations showed much better water quality result in comparison with the control sample (an unhandled sample which is daily used by the local communities).
- From the test samples, the concentration variations of the polluted substances were mainly: opaque, the content of BOD and the content of total iron.
- 2 chemical types used for the test samples of this thesis are very common chemicals used by the rural local communities. However, in comparison with the dosage as instructed by the rural clean water and environmental sanitary centres, the thesis performed the test models in more details and found out specific data which were more consistent with the current water source quality of the Mekong Delta. The specific data concerning the possibility of handling opaque in water are as follows: the analysis results showed that the best quality was achieved by the samples M4 (1g of PAC, 1g of chloramine, time of stirring and mixing 20 minutes), M7, M8, M9 (1, 2, 3 g of PAC respectively, 0.5 g of chloramine, time of stirring and mixing 30 minutes), for the measurement duration of 12 hours; the possibility of handling BOD in water: the analysis result showed that the best quality was achieved by the samples M7, M8 (1, 2 g of PAC respectively, 0.5 g of chloramine, time of stirring and mixing 30 minutes), for the measurement durations of 9 and 12 hours; possibility of handling the content of total iron in water: the analysis result showed that the best quality were achieved by the samples M7, M8 (equivalent to 1, 2 gram PAC, 0.5 gram chloramine, time of stirring and mixing is 30 minutes), for the measurement duration of 6 hours; and, the analysis result also showed that the possibility of handling the content of *E.coli* in water is the best for the measurement duration of 9-12 hours.

Model 2. A model of simple water filtering and container sterilization (household size)

1. Basic information regarding the model implementation

The basic information includes:

- Water source for use: surface water source,
- Range of application: household,
- Handling capacity: 500 litres/day,
- Used tools: 3 plastic water containers, a volume of 120 litres/container; filtering materials, aluminium chloride and chloramine B,
- Used chemicals: aluminium chloride and chloramine B,
- Chemical norms: using 3-6 g of aluminium chloride and 0.5 gram of chloramine B for 100 litres of water to be handled (the dosage of aluminium chloride is the test coefficient, the dosage of chloramine B shall be applied according to the guidelines for current products sold on the market).

2. Implementation process

In this pilot model, the author used simultaneously 6 test samples with the same amount of water of 100 litres. However, the dosage of aluminium chloride and filtering materials changed (sands, activated carbon and gravels).

Test samples:

- M1-M3: the dosage of aluminium chloride changed (3 g, 4.5 g, 6 g), the chloramine B dosage was the same (0.5 g) and as the filtering materials sands and gravels were used. Control Sample 1 (DC1) did not contain aluminium chloride and chloramine.
- M4-M6: the dosage of aluminium chloride changed (3 g, 4.5 g, 6 g), the chloramine B dosage was the same (0.5 g), and as the filtering materials sands, activated carbon and gravels were used. Control Sample 2 (DC2) did not contain aluminium chloride and chloramine.
- M0: the sample did not contain aluminium chloride, chloramine and filtering materials as well.

Implementation steps:

- B1: preparation of filtering materials.
- B2: preparation of used chemicals: dissolving aluminium chloride in 1 litre of water.
- B3: evenly stirring and mixing the mixture of water and aluminium chloride according to the guiding norm in the rough water container for 30 minutes. After that, pumping the water to the container containing filtering materials. Here, the water shall be handled and filtered via layers of filtering materials (sands, activated carbon and gravels).
- B4: after being filtered, the water shall be contained in a clean water container. The solution of chloramine B shall be directly stirred and mixed in the clean water container.

3. Analysis parameters:

pH, colour, opaque, TDS, DO, COD, NH_4^+ , NO_3^- , chloride, total iron and *E. coli*.

4. Implementation results of the model:

The analysis results of the water sample in the test containers and the control container showed that the water after being handled met the requirements of the clean water supply standard QCVN 01:2009 [3]. The effectiveness of handling the content of colour, opaque, BOD, chloride, total iron and *E. coli* via samples is shown in Fig. 6.

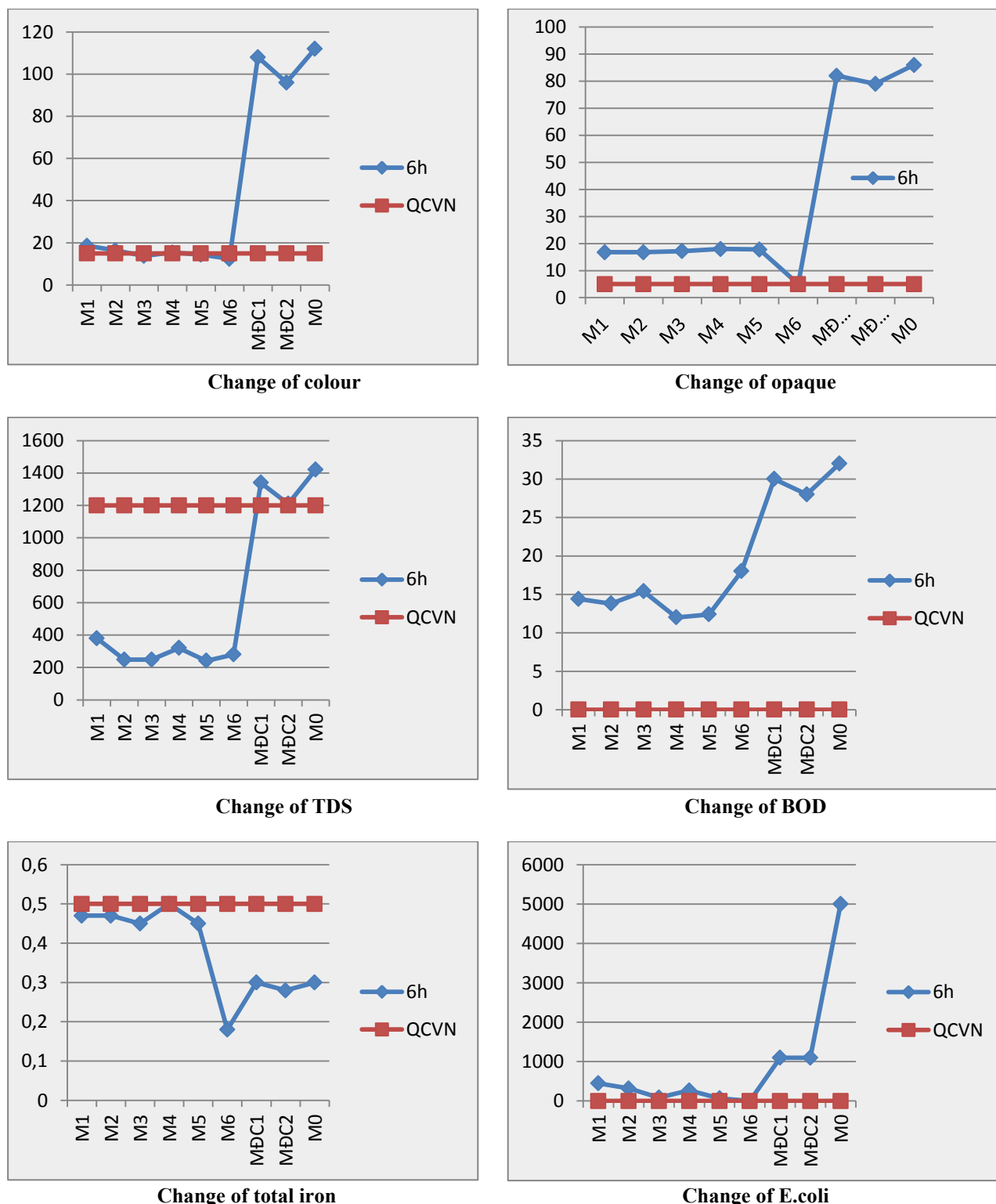


Fig. 6 Efficiency of water treatment

From the values in the figures above showing the content change of polluted substances (colour, opaque, TDS, BOD, total iron, *E. coli*) according to each test sample after 6 hours of doing the experiment, the following conclusions may be made:

- The test results of the samples M1-M6 also showed much better water quality in comparison with the control sample (M0 – the unhandled sample. The local communities currently use this water for their daily activities; MDC1 – the sample filtered via sands and gravels, MDC2 – the sample filtered via sands, activated carbon and gravels).
- Via the test samples, the variations in the concentrations of polluted substances relate mainly to opaque, TDS, content of BOD and total iron.
- 2 chemicals used in the experiments of this thesis are commonly used by the local rural communities. However, in comparison with the dosage as guided for the use by rural clean water and environmental sanitary centres, the thesis performed the test models in more details and found out specific data which are more consistent with the current water quality of the Mekong Delta. The specific data are as follows: the possibility of handling opaque and TDS in water: the analysis results showed that the best quality was achieved by the sample M6; the possibility of handling BOD: the analysis results showed that the best quality was achieved by the sample M4; the possibility of handling the content of total iron and E.coli in water: the analysis results showed that the best quality was achieved by the sample M6; and, the samples of M4-M6 (filtering materials of sands, activated carbon and gravels) showed the better analysis results in comparison with the samples M1-M3 (filtering materials of sands and gravels). This showed that the possibility of handling and filtering the polluted substances of activated carbon was better.

As a result, the analysis results from the test samples showed that the used chemicals of aluminium chloride, the sterilization chemicals of chloramine B in combination with the common filtering materials such as sands, activated carbon and gravels allow the local communities in flooding and rural areas to handle the surface water source meeting the required standards for daily use of the water. The dosage of used chemicals showing the best result is 6 g of aluminium chloride, 0.5 g of chloramine B used for 100 litres of water.

In general, the model 1 is the most suitable way for the people in the residential cluster in the Mekong Delta.

3.2 Model of waste water treatment

Model 3. A model of waste water treatment using a biogas tank (using a soft rubber bag)

1. Basic information in respect to the model implementation

The basic information includes [4]:

- Waste substances need processing: handling waste water and dungs,
- Implementation range: household size,
- Implementation model: model of biogas, use of incubating bags,
- Material for making biogas bags: polyethylene soft plastic,
- Size of implementation model: 1 model/1 household,
- Volume of biogas bag: 10 m³/bag,
- Number of pigs of each household: 30-35 pigs.

2. Implementation results

Tab. 1 The analysis results of input and output water samples after being handled with a biogas bag

No.	Analysis parameter	Model Biogas 1		Model Biogas 2		QCVN 24 : 2009
		Input	Output	Input	Output	
1	pH	6.5	6.7	6.5	6.7	5.5 – 9
2	SS (mg/l)	1,100	590	900	496	100
3	BOD (mg/l)	900	214	980	206	50
4	COD (mg/l)	1,120	312	1100	307	100
5	NH ₄ ⁺ (mg/l)	180	82	212	112	10
6	NO ₃ ⁻ (mg/l)	4,2	3,8	4,2	4,0	-
7	NO ₂ ⁻ (mg/l)	0.03	0.02	0.03	0.02	-
8	Cl ⁻ (mg/l)	78	54	67	62	600
9	N total (mg/l)	280	120	218	168	30
10	P total (mg/l)	160	62	120	48	6
11	Coliform (MPN/ml)	4.3x10 ⁵	2.1x10 ³	3.8 x10 ⁶	5x10 ³	5x10 ³

Source: The result from measuring the samples in March 2011 at the Institute of Tropical Techniques and Environmental Protection and reference to the results from the topic “researching to propose feasible environmental sanitary solutions in and after floods in Mekong delta – code KC 08.03/06-10”.

The results from implementing the model in 2 households in the Binh Hoa Dong & Binh Hoa Tay residential areas in the Moc Hoa district and Binh Thanh commune, Duc Hue district, Long An province show that the effectiveness of handling polluted substances under the model is very high, from 50-80 %, particularly as for organic substances, nourishing substances, odour and microbiological contents. *In fact, this is the waste water treatment model that is the most suitable for the residential cluster in the Mekong Delta.*

3.3 Model of sanitary toilet

Model 4. A model of toilet using a soft rubber bag (this type may be used for those households living on boats – this is a long-term living type of households in flooding areas).

Basic parameters with respect to the model implementation

The basic parameters include [5]:

- Handling waste substance: waste water and dungs,
- Implementation range: household size (this may be used for those households which live on boats – this is a long term habit of households living in flooding areas),
- Types of used materials: composite plastics with polyester fibres and composite solid plastics with glass fibres.



Fig. 7 Sanitary toilet

The model of the toilet using the soft rubber bags is performed on the basis of materials which are macromolecule compounds, mainly composite materials which have high physic mechanical characteristics, are light and durable under the weather conditions in the Mekong Delta. This model uses two types of materials which are composite plastics with polyester fibres and composite solid plastics with glass fibres [6]. This model has its advantages: it is neat, light, easy to carry & install, high durable and resistant to climate and weather conditions in the Mekong Delta as raining and flooding.

3.4 Model of handling garbage

Model 5. Model of raising worm (using waste from daily activities)

1. Parameters for the model design

Parameters for the model design include [7]:

- Model size: 1 model/1 household,
- Container for containing worms: containers may be made of bricks, or plastic containers, wooden containers may be used,
- Container size: $D \times R \times C = 1\text{ m} \times 1\text{ m} \times 0.7\text{ m}$,
- Used materials: organic garbage, worms, sand, heavy earth, dry cow dungs,
- Daily addition of garbage: 1.0-1.5 kg (mainly redundant food, shells of vegetables, fruits, etc.),
- Time for duplicating the worm size: 3 months,
- The structure of the container is shown in Fig. 7.

2. Test results of the model

The test results of the model which was applied in households in the Gao Long Den residential area, Tan Cong Chi commune, Tam Nong district, Dong Thap province showed that the model of handling organic garbage by earth worms may be used for each household to reduce the garbage arisen at the place where they come from. This is one of the best effective measures to positively contribute to the environmental protection. Each household only needs a container with a volume of 1 m^3 containing 1 kg of worms; the daily input food waste may be completely handled. In addition, this method may be applied in markets, food producing plants or commercial sized garbage dumps. We can collect not only worms but also their dungs as fertilizers.

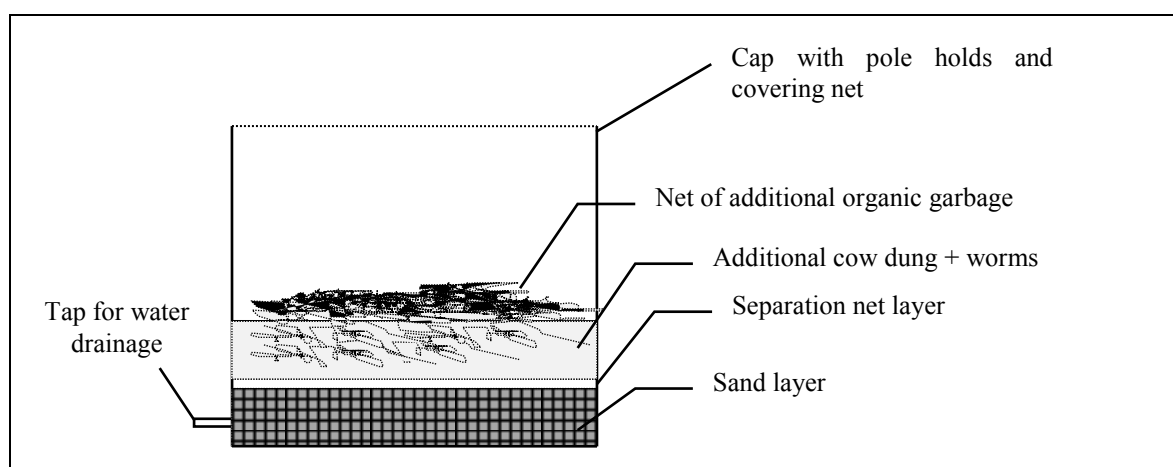


Fig. 7 Structure of the container handling daily garbage by worms

4 CONCLUSION

The residential clusters represent a new settlement type with new practices which are different from the long term habits of local communities in the Mekong Delta. The new habits and practices with respect to the environmental sanitary field shall greatly contribute to the environmental sanitary quality in the new community [7]. As a result, in planning and choosing models for clean water supply and environmental sanitary works in such residential clusters, attention must be paid, in addition to the requirements of sanitary criteria, to the appropriateness of culture and habits of the local communities. In addition, programmes of environmental education and new lifestyle of environmental friendliness must be set up and implemented concurrently for the local communities in such residential clusters.

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