A Project Proposal under the theme of

Infrastructure development under increased flooding/storm intensity

"The KUND System:

A sustainable way to ensure drinking water supply in the rural Mekong Delta under flood conditions"

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Contents:

I. BACKGROUND

The study area is located in the lower Mekong River Delta (MRD), an area that has experienced negative consequences from agriculture development, but also benefits from the nutrient-rich water it receives. The Mekong River Delta has a favorable weather conditions for agriculture year round, with average yearly rainfall of 1.4-2.2mm. With an area of around 36,000 km^2 (accounting for 4% of the total area of the Mekong River Delta), the region has a total population of around 17 millions of people (24% of the total national population) and an agricultural land area of around 2 million of ha [1].

Figure 1. Mekong River Delta located in Vietnam

Local residences have historically dealt with a long list of water related issues, particularly (up to 1.4-1.9 million ha); salinity intrusion (up to 1.2-1.6 million ha), acidic water and acid sulfate in the soil (up to 1.0 million ha), and shortages of potable fresh water (up to 2.1 million ha) [2]

A literature review shows that according to government survey data, the main water supplies in the delta for household daily use (other than drinking and/or cooking) are rivers, lakes and ponds (36%), followed by wells (34%), and piped systems (21%). For drinking and cooking, rainwater is a primary source (23%) together with wells (26%), and rivers, lakes and ponds (25%) ([3]). With rapid and sustained economic growth in Vietnam since the 1990s (World Bank, 2002), demand for improved water sources and services is expected to increase. Although rainwater has been utilized using cisterns, 30% of which above ground and 70% submerged in the ground, it still doesn't meet people's needs for fresh water supply. More data is needed about rural populations and household distribution with respect to

climatic characteristics, since the climate in Vietnam is very different from that in India, where cistern systems have been used for harvesting rainwater. There is also a need to calculate the climatic anomalies over the Mekong Delta which may impact rainfall.

Figure 2 shows that underground water depletion in the region has been more serious in the central provinces; darker color indicates higher groundwater drawdown rates. Provinces in dark orange have had water level decline the most, with a rate of 70-80cm/year, and other provinces in the border lands and near the East Sea have experienced lower drawdown rate [4]. Similar figures are also seen from the compaction-based subsidence rate, showing that the subsidence rate is higher at the center of MRD with a rate of 3cm/year and areas near Cambodia have a lower subsidence rate of below 0.75 cm/year. Regarding salinity intrusion, data from February, 2016 show that salinity intrusion of areas bordering the East Sea, such as Sóc Trăng, Cà Mau, Bạc Liêu, Trà Vinh and Bến Tre reach 24g/l, while other provinces bordering Cambodia only reach around 0.1g/l (SSI, 2016).

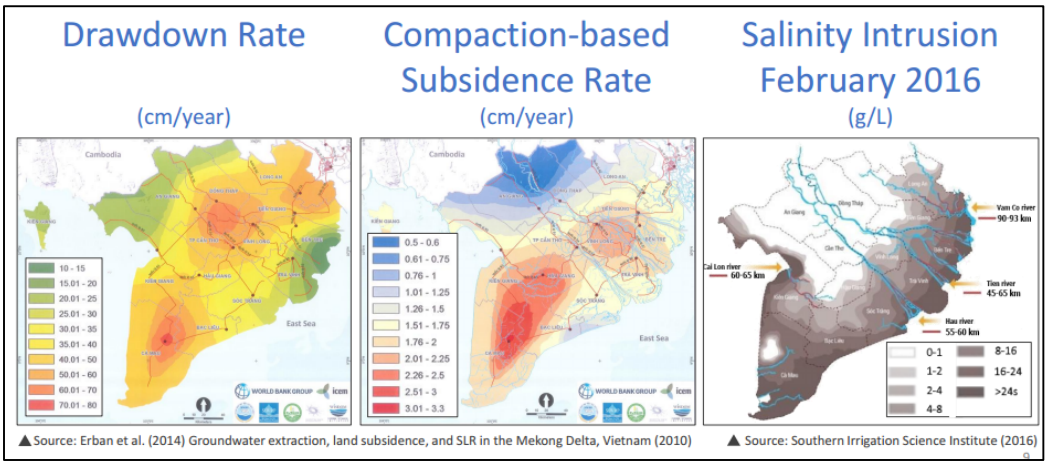

Figure 2. A few water related issues in Mekong River Delta in Vietnam

However, the majority of the water supply for the region is from bottled water (67.7%) for both the rainy season and dry season [5]. Although there are abundant water resources in the area with a high amount of average precipitation annually, an efficient tool for harvesting rain water is still needed in order to meet the high water demand in both rainy and dry seasons. In the future, with the effects of climate change compounding the above mentioned issues, local households will continues to depend on bottled water due to lack of access to water supply sources. Currently in the MRD, rainwater is collected by individual households and then stored in tanks that are situated in their yards. This type of rainwater collection is not very efficient due to limitations of the yard area and the expense of construction (Figure 3). Because the region will be even more densely populated in the future, it is necessary to find out more efficient ways to gather rainwater for reuse in both the dry and rainy seasons. One such was

would be a KUND system, which has been successfully applied within many countries in Asia, such as India, and could be implemented in the MRD. This type of system would ensure drinking water supply in the rural Mekong Delta under flooded conditions.

II. AIMS & OBJECTIVES

Although water is omnipresent in Mekong River Delta (MRD), the drinking water supply is still a challenge, especially in the rural areas. The aim of this study is to find out what type of efficient infrastructure can ensure drinking water supply in rural areas of Mekong River Delta under flooded conditions. Currently, due to the tropical climate, rain water is only available during the rainy season. Storing rain water requires ideal hygienic conditions which are not always available. Also, the existing drinking water treatment plants are designed according to one scheme, which does not consider the quality of the raw water. The current practices for rainwater harvesting in rural areas of MRD is not efficient or effective. However, the KUND system which is widely used in rural India could be an efficient way of overcoming the drinking water supply challenges in the MRD. KUND, the local name given to a covered underground tank, was developed primarily for tackling drinking water problems. They are more prevalent in the western arid regions of Rajasthan, and in areas where limited groundwater is available, or where the groundwater is moderately to highly saline. Under such conditions, KUNDs provided convenient, clean, fresh water for drinking. From other countries' experience, we can easily find the way to address Vietnam's drinking water challenges.

The objectives of the project would be:

Aim: To ensure drinking water supply in rural Mekong Delta under flooded conditions.

Research Question: What type of efficient infrastructure will ensure the drinking water supply in rural Mekong Delta under flooded conditions?

Research Objectives:

- **Objective I**: To identify current practices for rainwater harvesting in the rural areas of the Mekong River Delta.
- **Objective II**: To review the KUND system for rainwater harvesting.
- **Objective III**: To identity the rural population and household distribution with respect to climatic characteristics.
- **Objective IV:** To implement a KUND system in rural areas of the Mekong River Delta.

3. RESEARCH METHODOLOGY

This section describes the research methodology used to solve the specific research question listed in the previous section. The major issues to be solved include:

A. Main water source and current practices in rainwater harvesting along Mekong Delta

The identification of the main water source/ supply along Mekong Delta area will basically be done by data collection from government or private agencies together with little of the literature review through search engines 'SCOPUS' and 'Google Scholar'. The keywords chosen for the search include: 'fresh water supply', 'water source', 'rainwater', 'Vietnam', 'Mekong Delta', and 'rural area'

For the identification of the current rainwater harvesting practices along Mekong Delta, majority will be done through literature review via the searching of keywords: 'rainwater harvesting', 'Vietnam', 'Mekong Delta', and 'rural area'. Data collection from local government and private agencies will also be conducted to ensure the completeness of the data collected.

For both cases, ground survey in the targeted rural areas will also be conducted. Below listed some major questions that will be included in the survey:

- Where you usually get the fresh water supply?
- How you treat the water to ensure the safety use of it?
- How you think about your current water supply?
- Do you familiar with rainwater harvesting?
- Do you feel safe if taking rainwater as drinking water?

B. Review on KUND system

KUND system is a traditional rainwater harvesting technology that applied in desert area which having limited groundwater and fresh water supply with the long period of dry season. Vietnam is facing some similar issues since the abstraction of groundwater is prohibited due to the Arsenic pollution and land subsidence, the insufficient of safe water supply due to the pollution of Mekong Delta, as well as the difficulty in fresh water supply during flooding season. Thus, in this study, KUND system is proposed to solve the fresh water supply issue in rural area along Mekong Delta.

However, the detail review of KUND system is essential before the implementation of the system, especially when it is a relatively new concept in implementing a KUND system in Vietnam. The review on KUND system will be done by literature review through search engines 'SCOPUS' and 'Google Scholar' via the searching of keywords: 'KUND', 'rainwater harvesting', 'efficiency', and ''. Official reports from

countries or districts that using KUND system will also be collected to identify the pros and cons of the system, as well as the difficulties faced when implementing the system.

Instead of only review on the system, technology and efficiency of KUND system, the maintenance of the system and the economy analysis of building, operating and maintaining of the system also a crucial part of this sub-section. Most of this information also expected to collect from the official reports and literature review.

C. Identify on current and future water demand in rural area along Mekong Delta

In order to identify the current and future water demand in the selected area, it is essential to collect the information about the total population and household distribution. This information will be collected from local government and private agencies. Beside the total population and household distribution, the climatological information will also be collected. The climatological information will include the intensity and frequency of rainfall, temperature different, and flooding frequency. These data will be collected using GIS satellite mapping. GIS satellite mapping will also be used to decide the favorable location for implementing KUND system. Lastly, data analysis will be conducted to select the best location to implement KUND in the selected area and its respective capacity.

D. Implementation of KUND system

This sub-section includes the optimization of the design of KUND system specific for the selected area by considering the population and climatological information, calculation of the cost of setting up KUND system (including capital cost, labor cost, operating cost, and maintenance cost), training of residence in using the system after implementation, and the post-implementation survey after the implementation of KUND system in the selected area.

More than three contractors will be invited to quote for the project. Before selected the contractors, each contractor will be evaluated not only based on the construction cost given, but also their previous project quality and the reputation of the company in order to give a better quality and safety outcome. After the built up of the KUND system, to ensure the safety use of the rain water collected, expertise will be invited to train the residence in using the system, as well as the proper way in treating the water collected. Campaign related to proper water use will also be conducted to improve the people awareness in saving water resources, safety use of water, and how to prevent and reduce the pollution in water source. Lastly, ground survey will be done among the residence that can access the KUND system in order to improve the current or future project. The questionnaires or interview will include the following questions:

- How you felt about the KUND system?
- Is it helping you to get a cleaner and safer water source?
- Is the system easy to operate?
- Do you think the system is providing enough water?

Future improvement of the implemented KUND system might be necessary based on the ground survey taken. Figure below showing the flow chart in conducting this project.

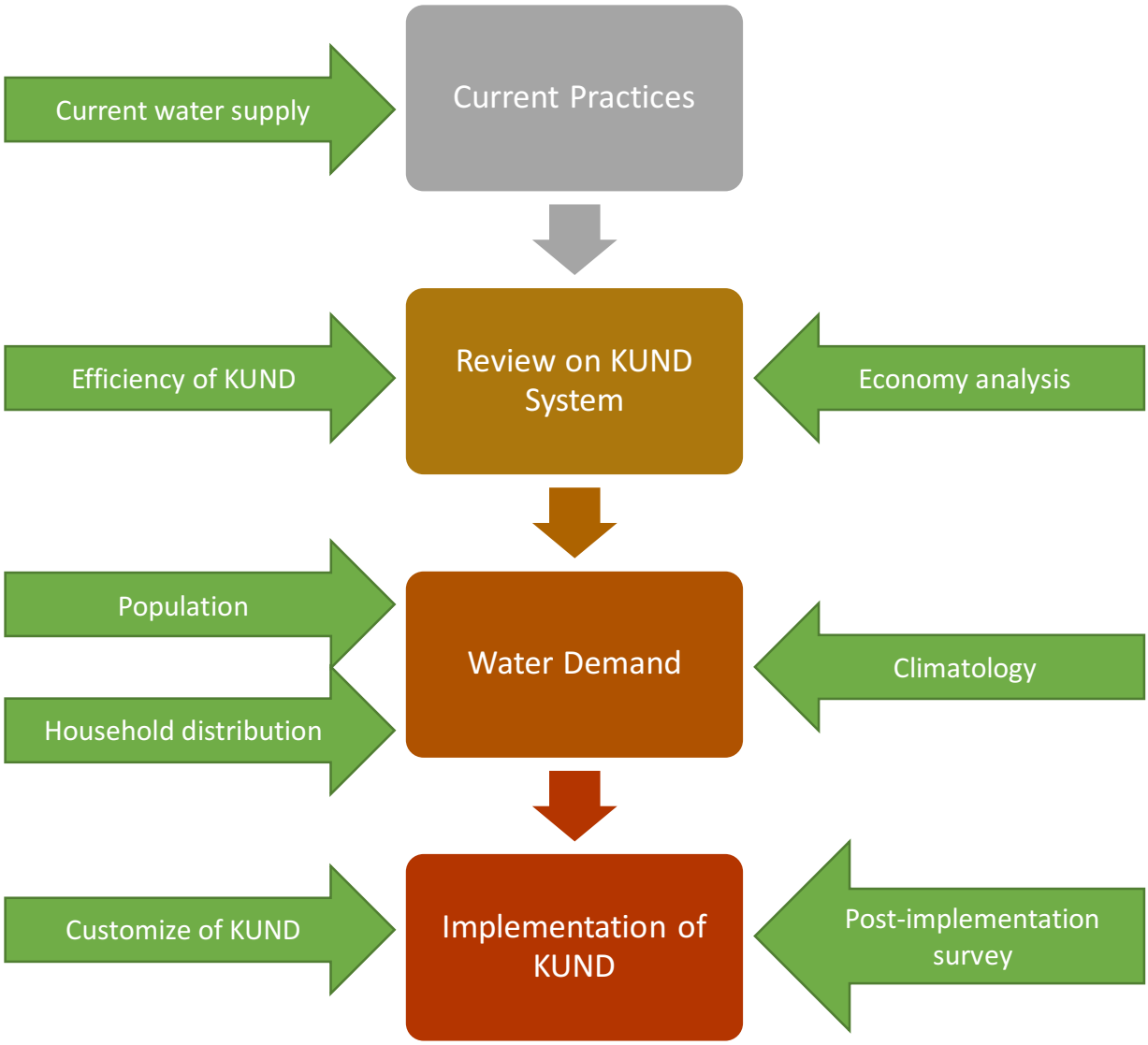

Figure 3: Outline for the proposed work.

III. DESIGN FOR THE KUND SYSTEM

The KUND system is a traditional rain water harvesting system used primarily in rural areas of India under deficit drinking water conditions. It is a low cost, easy to assess , and easy to build system. The KUND consists of a saucer-shaped catchment area with a gentle slope towards the centre where a tank is situated (Figure 4). Openings or inlets for water to go into the tank are usually guarded by a wire mesh to prevent the entry of floating debris. The top is usually covered with a lid from where water can be drawn out with a bucket with the help of a pulley system. KUNDs are by and large circular in shape, with little variation between the depth and diameter, which ranges from 3-4.5 m. The success of a KUND depends on the selection of the site, particularly its catchment characteristics. An adequately large catchment area has to be selected or artificially prepared to produce adequate runoff to meet the storage requirements of the KUND. The catchment size of a KUND varies from about 20 square meters to 2 hectares depending on the runoff needed and the availability of spare land.

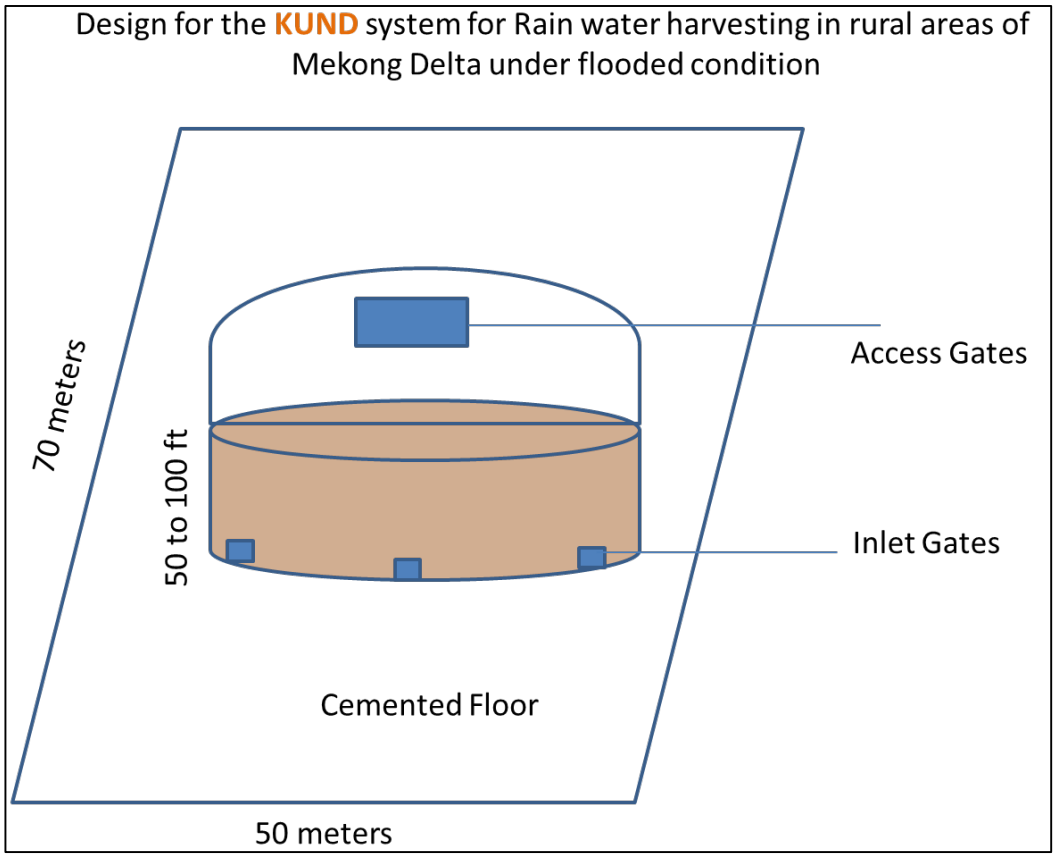

Figure 4: Design for Kund system

Implementation of a customised KUND system along the Mekong Delta would be an efficient and effective rainwater harvesting system for fulfilling the water demand of the region. A decrease in the dependency of bottled water and an increase in water storage would be observed under flooded

conditions. As per the final stage of the project, a post implementation efficiency assessment would be performed for the KUND system.

IV. Timeline

The following timeline is proposed with the consideration of implementing two KUND systems for single village with the population of approximately 5000 residents.

Planned submission:		Expected time to complete the project:											
Project component	Time (e.g. Month)	1	2	3	4	5	6	7	8	9	10	11	12
Literature review													
Data collection													
Data analysis/ Infrastructure development													
Policy recommendation													
Write up													

References:

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[3] S. P. House, “Møc sèng hé gia ®× nh N ¨ m 2008 Result of the survey on household living standards 2008,” 2008.

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[5] G. Hutton, L. Haller, and J. Bartram, “Global cost-benefit analysis of water supply and sanitation interventions,” pp. 481–502, 2007.