Management of Water Resources in Wetlands (Muarajambi Watershed Case Study)

S M Siregar
Environmental science doctoral program, Sriwijaya University
Corresponding author: siregarsondang@yahoo.com

Abstract. In Muarajambi temple, there was founding of good water resources, such as surface water and ground water resources. The local people in Muarajambi have managed water resources both inside and outside of the Muarajambi complex. The problem is how to describe the management of water resources in the Muarajambi area. The purpose of this study was to determine the description of water resources management in the Muarajambi area by analyzing the distribution, form, function from the management of water resources in Muarajambi area. The results performed that the water resources in Muarajambi area were spread over a fluvial landscape with a height of 0-20 meters above sea. The water resources consist of surface water resources and ground water sources. There are natural and artificial surface water resources. Natural surface water resources consist of rivers, lakes and swamps and artificial water resources consist of canals, ponds and ditches. The resource of ground water is a well which was made by human contains a spring inside. The management of water resource is divided into 3 (three), namely at the micro, meso and macro scales. Micro management of water resources is making of water holes in the temple building, ponds and wells in the yard of temple. Messo scale management of water resources is the construction of a pond in the yard of the temple and the making of a trench around the temple. Macro scale management is the creation of canals (artificial rivers) between temples. The function from management of water resources in Muarajambi area is a drainage (channel for regulating water into and out of the temple building), as a water storage area during the rainy season, as a means of daily needs and ritual needs (ponds and wells) and means of transportation between temples (river and canals)

Key words: management, channel, water, temple

1. Introduction

Wetlands are swamps that are often inundated by water, seasonally or annually. [1] Wetlands are lowlands that have a high, flat and hollow location [2]. In wetlands there is a high and flat location. Generally, these locations are dry locations and not exposed to stagnant water [3] Wetlands provide the necessities of human life [4]. Humans interact in wetlands in order to meet the needs of their life [5] Interaction consists of the process of choosing and making decisions, to face the potential and conditions of constraints in the environment. [6]. Humans try to fulfill their daily needs, so humans use their minds and take advantage of nature so that cultural objects are created. [7] Cultural objects are a description of human knowledge and experience in interpreting the natural surroundings. [8] These cultural objects are related to placement of human in the earth, including the placement of temples for religious activities [9] one of the cultural objects in the wetlands is the Muarajambi temple, especially in the Batanghari River. Muarajambi temple area based on the master plan which was made by the Regional Government of Muarajambi in 2006, it consists of 6 areas, namely area 1: Gumpung temple, Tinggi temple, Kembar batu temple, Telagorajo pond and surrounding menapo-menapo, area 2: Astano temple and several nearby menapo, areas 3: Gedong temples 1 and 2 and surrounding menapo-menapo, area 4: Kedaton temple and surrounding menapo-menapo, area 5: Kuto mahligai temple and Sengalo Hill and the surrounding menapo-menapo, area 6: Teluk temples 1 and 2, Chinese Menapo [10].

In Muarajambi area, water resources are scattered. In the past, it was estimated that the community had knowledge in utilizing water resources. Utilization of water resources is an effort to manage water resources in a balanced manner. This is due to a consequence of the nature of water flowing from
upstream to downstream by gravity which is influenced by the hydrological cycle, regional conditions, the activities of living things, so there is a need for efforts to balance the availability of water resources in an area. People in Muarajambi have managed water resources for daily needs and ritual needs. This management of water resources is also carried out in order to escape the threat of flooding during the rainy season or drought during the dry season. The problem is how to describe the management of water resources in Muarajambi. This question is expected to be known from the research objectives, namely a) knowing the distribution of water resources in Muarajambi area, b) knowing the water resources management space c) knowing the function of water resources management in Muarajambi. The benefits of the research are a) the input for the conservation of the Muarajambi temple, b) input for the normalization of river activities in Muarajambi temple c) the input for the conservation of water resources in the Muarajambi area.

2. Research Methods
The research area is the Muarajambi temple area located in Muarajambi Village, Marosebo District, Muarajambi Regency. The method used in this research is a qualitative study, namely descriptive research with inductive reasoning. The basic theoretical is used as a guide so that the focus of research is related to the facts in the research area. The focus of the research is to reconstruct the management of water resources [11]. In the early, collecting the secondary data consisted of research reports and previous maps. Documentation activities are using camera, video and drone equipment. Field observation surveys were also carried out to verify the map data that had been obtained and to focus on new data in the field. Field observations are the descriptions of the distribution of the temples and water resources, especially their location on the Muarajambi temple. The descriptions were carried out on a micro scale for the area inside temple 1 building and the messo scale for the temples complex (consisting of several temples, ponds, rivers, ditches within 1 complex), and a macro scale consisted of a combination of several temple complexes in Muarajambi. After that, a description of the space is carried out, then a description of the function of water resources is carried out based on micro, meso and macro scales. Data correlation analysis, in particular, performed comparative analysis of the placement and function of water resources at the micro, meso and macro scales. Based on the results of the correlation between the micro, meso and macro space data, so that data interpretation will be carried out

3. Analysis and Discussion

3.1. Water Resources in the Muarajambi Temple Area.
Water resources in the Muarajambi area consist of surface water and ground water resources. Ground water resources are springs which were found in the Muarajambi temple. In the Muarajambi temple area, ground water resources were found which were made same as the establishment of the temple, such as the Kedaton Temple well. The well is made of bricks and has a depth of 4 (four) meters. During the rainy or dry season, the well still contains water.

Surface water resources found in Muarajambi area consisted of natural and artificial surface water resources. Natural water resources consisted of swamps / lakes and rivers. In map, we saw with blue colour (Figure 1). Artificial water resources are canals, ponds and ditches. Lake / Tebat / Payo is the surface of the land in the form of basin which contains water. Generally, lakes / swamps are used by residents as a place to keep fish and belong together, such as Terjun Gayo Payo, PayoTerbakar, PayoLubukGede, PayoBakakko, PayoTeliti, PayoSematangRamang, PayoSematang Mango, Payo Teluk Dekat, Payo Teluk Jauh, Payo Sunga Kamal, Payo Seberang, PayoJangkang, Payo Danau Kelari, Payo Selat, Payo Lubuk Serapil, Payo Elang Ngantuk, Payo Sematang Belubur, Payo Lopak. A river is waterways that has several variations of width. In the Muarajambi temple area, several waterways are divided and have local names, namely baluran, sakean, buluran, ditch, river, trunk, estuary, kuala. Baluran is a small trench, measuring 20 cm to 50 cm wide, sakean is waterways measuring 50 to 100 cm. Sakean is a waterway that comes out of the lake. Buluran is a water channel that comes out of the
trench of the temple, has a width of 100 cm to 200 cm such as the buluran keli, buluran paku, buluran lebat, kemang buluran and kale.

The ditch is a waterways/ditch that surrounds the temple or connected between temples, has a width of about 2 (two) meters to 6 (six) meters such as Trench Johor, Sekapung ditch, Duku ditch, Candi Astano ditch, Kembar Batu ditch, Telago rajo ditch, Rambung ditch, Bolo ditch, Menapo Ruslan ditch, Buffalo Stables Menapo Ditch. So far there is confusion with the local term “ditch and river”, such as the Johor ditch and the Sekapung ditch, which flow liner on the north side, because there are also references to the trenches surrounding the temple such as kembar batu ditch, Astano ditch. So the author indicates that the Johor ditch and Sekapung are not natural rivers but the people used to make artificial rivers as a link between temples. Like a natural river in a linear position on the south side of the Muarajambi area.

A canal is a man-made waterway that has a width of more than 6 (six) meters and a straight laying position. The canals were found in Muarajambi area such as; Jambi River, Seno River, the Selat River, the Sekapung River. Meanwhile, the waterways were elongated but the flow tends not to be straight because it collides with the rocks on either side of the river when digging. The rivers in the Muarajambi area are the Berembang River, the Amburan Jalo River, the Medak River, the Terusan River, the Keliling River, the White River, the Kandis River, the Kemingking River, and Simpur River. The trunk is a place for rivers such as the Batanghari River. Muarajambi is a local term, where the trunk meets small rivers. Meanwhile, the place where the trunk meets the sea is a kuala like Kuala Tungkal. The pool is a basin-shaped surface which contains water. The pond is man-made, generally functions as a place to collect water and a place to keep fish. Generally, the ponds are private property, such as the Telagorajo pool, the Tinggi Candi pool, the large gumpung pool, the small Gumpung pool, the Jambi River pool, the chicken pool, the fish cage pool, the Kedaton pool, and the pool near the BPCB Jambi office mess.

Figure 1. River, Ditch and Payo/Lake in the Region of Muarajambi Temple, Jambi Province
3.2. Management of Micro, Messo and Macro Water Resources.

Since the Sriwijaya era, the management of water resources in wetlands has been known. This is proven by the discovery of an inscription from the Sriwijaya period, namely the Talang Tuo inscription which contained the concept of environmental management, especially in wetlands [12]. Raja Dapunta hyang Sri Jayanegara ordered to build a dam, pond and lake and plant sago, coconut and areca trees for the prosperity of the people. [13] The king of Sriwijaya knew that his territory was in wetlands. The construction of dams, ponds, artificial ponds, lakes is a manifestation of environmental management in wetlands with the aim of storing water. In the rainy season, water collected in dams, ponds and telago to avoid flooding. In the dry season, the location does not dry out because it has water reserves. The king also asked to plant swampy plants such as sago palms, coconuts, and areca nuts. These plants will grow and bear fruit because they are planted in accordance with their habitat, and bring fertility to the swamp land.

Muarajambi area already has an environmental management system, consisting of micro, messo and macro environmental management. Micro environmental management is management with a small space scale, namely temples, such as the holes found on the walls of the Kembar Batu Temple, this hole indicates the existence of water management which functions to keep the temple building dry and remove liquid waste from the building of temple (Figure 2). At Kembar Batu temple is found ditch that was surrounded temple. That ditch functioned as water drainage (Figure 3). At Kedaton temple, a culvert is found under the temple wall which is also used to waterways from inside the temple to the ditches around the temple. In the building of temple, there is jaladwara. Jaladwara is a rooftop decoration in the form of a dragon animal with an open mouth. This open mouth functions as a waterway.

Besides that, it was found that the distribution of gravel crust came from crypto crystalline quartz, chert, obsidian and basalt gravel and appeared to be scattered in the inner and outer courtyards of Kedaton temple. Gravel is placed on the foundation of the temple. The gravel has high porosity and permeability and is a useful foundation for reducing soil wetness and preventing the temple foundation from weathering/damage due to water immersion.

Semi-macro environmental management is the management of the environment between the temple and the waterways around it such as buluran, sakean, buluran, trenches and wells. The trenches that surround the temple function as water reservoirs when water is abundant during the rainy season, and water reserves during the dry season such as the Telagorajo pool, the Tinggi temple pool which were located between Gumpung 1 and Tinggi temples, 2 pools in front of Gumpung temples, and Kedaton temple ponds. which is on the left and right porches of Kedaton temple, and Kelari Lake. Besides that, an old well was found in the Kedaton temple complex. Semi-macro environmental management is the construction of pools inside the temple or inside the yard of temple which is bordered by a fence, namely 2 high temple pools, Kedaton temple pool, and ponds outside the temple courtyard but the location is still close to the temple, namely the Tinggi temple pool, Telago rajo pool. Besides as a regulator of
rainwater runoff, these pools also function as a religious facility. The pool outside the temple is used by Buddhists to clean their bodies before worshiping at the temple. Meanwhile, the pools in the temple are holy water which is taken by priests as a means of ceremonial religious activities in the temple.

### 3.3 Function of Water Resources Management in the Muarajambi Area

The Muarajambi complex area is a fluvial material that has an elevation of 0-20 meters above sea. The area has the form of low land generally flood when rainy season, but the temples are not flooded when it rains. The temple cluster is located on a natural embankment bordering the Jambi River on the south side and the Johor Trench on the north side. The temple area is between the Berambang River in the north and the Amburan Jalo canal, Johor ditch and Sekapung ditch on the side of the river and the Jambi River, the Selat River on the south side. This area has the form of land generally floodplain, but the cluster of temples is not inundated because it is located on the deep embankment. In a long time ago, people have already had the knowledge in managing wetlands, so set up a temple in higher location than the surrounding high avoid from flooding. The approach to recognizing macro engineering at the time of the survey is to recognize the elevation. On the round side, the water will collect in the area during the rainy season. So there is a well-known local term that “when it rains, it's time for the water to drain”. This area is lakes which are very large in size and resource of water in the Muarajambi temple area. Every day, all the waterways in the Muarajambi temple flowed and circulated the lakes. When the rainy season, the water swamps up the swamps and when the lakes are full of water, the water turned back and flew into the ditch, ponds, buluran, sakean and baluran. The term sakean is a waterway which was made by humans, this waterways functioned to drain water from lakes and rice fields.

Based on the behavior of the water flow, it can be seen that the north-south river (canal) functioned as a water runoff network in the area. The river, which has a north-south line, functioned as a river for draining of rainwater runoff that falls in the area, part of the rainfall that fall into ponds that functioned as clean water, and excess water after being stored is flowed into the North-south canals, an example of a river (canal) that is between Gedong Temple and Gumpung Temple. The river from west-east functioned as a flood drain network associated with the Batanghari River. The flood drain area is a river (canal) in the area in contact with the Batanghari River which functioned to drain excess water in the area to be flowed into the Batanghari River, where the water flew from west to east. However, in certain circumstances, when the water level of the Batanghari River exceeds 8 meters above the sea, the water will flow from east to west, from the Batang Hari River into the environment / watershed area. Based on the river alignment pattern, we can see that the river is flooded from west-east is a natural river, while the north-south water runoff river is a natural water rope which is modified, wide and expand, such as the Amburanjalo River and the Jambi River in front of Astano.
4. Conclusion
The Muarajambi temple area is an embodiment of the water resources management concept in the past. The local people used to manage water resources by making water ways. The water ways functioned as water reserves during the dry season and protected from flooding during the rainy season. The local people utilize water sources in the Muarajambi temple area consisted of groundwater and surface water resources. Groundwater resources such as wells and surface water resources include water ways such as baluran, sakean, buluran, ditches, rivers (canals). The canals served as practical means such as transportation between temples, and drainage of water in the temple area. In addition to practical functions, the local people made pools both inside and outside the temple grounds for religious purposes.

5. References
[1] G. M. Kondolf, D. R. Montgomery, H. Piégay, and L. Schmitt 2005 Geomorphic Classification of Rivers and Streams, vol. 9
[2] J. M. Wheaton, K. A. Fryirs, G. Brierley, S. G. Bangen, N. Bouwes, and G. O. Brien 2015 Geomorphology Geomorphic mapping and taxonomy of fluvial landforms vol. 248 pp. 273–295 doi: 10.1016/j.geomorph.2015.07.010.
[3] F. Guetirrez 2016 Fluvial Landforms in Landform of the Earth pp. 155–176.
[4] S. M. Siregar 2008 Permukiman Masyarakat Teluk Kijing: Gambaran Adatasi Masyarakat terhadap Lingkungannya in Arkeologi Lahan Basah di Sumatera dan Kalimantan pp. 64–73.
[5] S. Prijo 2016 Aspek Adaptasi Dan Akulturasi Budaya Di Situs Bumi Rongsok, Tasikmalaya no. Archaeology pp. 1–16.
[6] H. Hanurhaza 2011 Cultural Landscape: A New Paradigm for Landscape Architecture Res. Gate pp. 1–7.
[7] K. Taylor and J. Lennon 2011 Cultural landscapes: A bridge between culture and nature? Int. J. Herit. Stud. vol. 17 no. 6 pp. 537–554, 2011 doi: 10.1080/13527258.2011.618246.
[8] R. L. Lyman 2007 What is the ‘process’ in cultural process and in processual archaeology? Anthropol. Theory vol. 7 no. 2 pp. 217–250 doi: 10.1177/146349960707077299.
[9] S. M. Siregar 2010 Permukiman Masyarakat di Situs Jepara (Gambaran Adaptasi Manusia terhadap Lingkungannya) Forum Arkeol. vol. XXIII no. 3 pp. 492–510.
[10] Y. H. M. Manurung 2018 Pengaruh Konflik Kepentingan Ekonomi dan Sosial Budaya terhadap Pelestarian Zona Inti Kawasan Cagar Budaya Muarajambi.
[11] P. S. Rahmat 2012 Penelitian Kualitatif J. Equilib., vol. 5 no. 9 pp. 1–8, 2009 [Online]. Available: yusuf.staff.ub.ac.id/files/2012/11/Jurnal-Penelitian-Kualitatif.pdf.
[12] S. M. Siregar 2018 Talang Tuo Inscription: The Management of Environmental in Sriwijaya Period Indonesia. J. Environment Management Sustainable vol. 3 pp. 80–83.
[13] Y. Yenrizal 2018 Makna Lingkungan Hidup di Masa Sriwijaya: Analisis Isi pada Prasasti Talang Tuwo ASPIKOM vol. 3 no. 5 pp. 833–844 doi: 10.24329/aspikom.v3i5.302.

Acknowledgments
Thanks to Balai Arkeologi Sumatera Selatan for providing funds for research activities in the region of Muarajambi temple which took place from 2019. Likewise, thanks to the regent of the Muarajambi temple, head of Marosebo Sub-District and Head of Muarajambi village who gave permission to carry out the research. Thanks to the research team of Muarajambi, informants, local personnel from Muarajambi Village who assisted in research activities in the field.