

Environmental Anthropological Study of Watershed Management-Water Quality Conservation of Forest as a Catchment Area in the Southern Part of Australia

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Abstract

Authors have conducted an experiment of irradiation using sound waves (frequency) including ultrasonic waves into water such as drinking water, sea water and forest water and wastewater so far. As a result, almost the same effect of improvement of water quality was confirmed for each sound wave. Then, an environmental anthropological study of watershed management based on the sound was carried out assuming that a water quality management using the sound could be possible. The Goulburn River basin in the southern part of Australia in which indigenous peoples (Yorta Yorta) have been concerned with the management for a long time so far was selected as an objective drainage basin this time. As a result, a couple of environmental anthropological perspectives on watershed management were proposed.

Keywords

Watershed Management, Water Quality Conservation, Water Quality Improvement by Sound, Murray-Goulburn River, Eco-Money (Environmental Tax)

1. Introduction

At present, the importance of sustainable water quality conservation of watershed/ forest as a catchment area has

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been pointed out all over the world [1] [2]. It is thought that if sustainable water quality conservation of watershed/forest is possible, the supply of drinking water with an abundant quantity, an inexpensive price and a good quality has also become a sustainable one [3]. For this purpose, a construction of “environment-social system” by the independent effort of water quality conservation driven by watershed community residents is required. It is necessary for that to make the system involved in the community for conserving the watershed. For instance, a construction of value-led management and a planning of environment investment strategy which become a mortgage of sustainability are required. Then, we carried out the survey of water quality conservation by the sounds at the indigenous communities nearby Murray-Goulburn river watershed in the southern part of Australia. And, an environmental anthropological consideration on a concrete and ideal method (watershed culture) on a construction of “environment-social system” by the independent effort of water quality conservation driven by the watershed community residents was done. Furthermore, based on the consideration, the proposal toward a water quality conservation of watershed/forest as a catchment area has been conducted, and also has been examined on the approach required in contrast with the independent effort of water quality conservation driven by the watershed community residents.

2. History of Natural Resource Management in the Study Area [4]

The main areas of our study are the Goulburn Valley that contains following towns around 200 km up to the north from Melbourne city; Echca, Moama, Barmah, Cummeragunga Aboriginal community, and Mooropna and Shepparton along the Golburn River diverging from Murray River. The Barmah forest is a part of the largest River Red Gum wetland in the world and the size of the forest including the Millawa forest on the New South Wales side is around 30,000 hectares. The forest has more than 385 species of indigenous flora and 273 species of indigenous fauna and is listed as a wetland of international significance under the Ramsar Convention. The Barmah forest contains many sites of cultural significance to the Aboriginal people. The study areas including the Barmah forest abound in the primal industry such as fruits, vegetables, rice, dairies, livestock and sawmills. Most of people running the forest and agricultural businesses are the descendants of the Anglo-Celt settlers who had immigrated into this area since 1840s (Figure 1) [5].

The primal industry, specifically the forest industry slashing and processing trees for rail way and for paddle steamer yielded the first output of all production in 1860s. In 1870s, Victoria colonial government enforced the Drought Proof Policy, which controls flood in Murray-Goulburn Broken Catchment. Thus, many regulators and water ways were constructed for irrigation and agricultural and farm industry increased output as second output of all production in this area. However excessive cropping by irrigation led to the exhaustion of the soil and the big cattle and sheep station got rabbit damage and extreme reduction of the market price. After enforcing the water policy for irrigation rights among three states; New South Wales, Victoria and South Australia, more facilities such weirs and dams for water allocation were constructed but these facilities caused to drought and saltation for agriculture. Consequently, disastrous drought has attacked the native fauna and for a high salinity was found since 1930s [6]. Three state governments did not coped with these issues until 1980s because they treated resources in the forest and river in the Murray-Goulburn Valley not as a part of eco system but as a part of productive resources [7]. In 1972, United Nations Conference on the Human Environment was held in Stockholm and environmental issues become international agenda thus, natural conservation was the

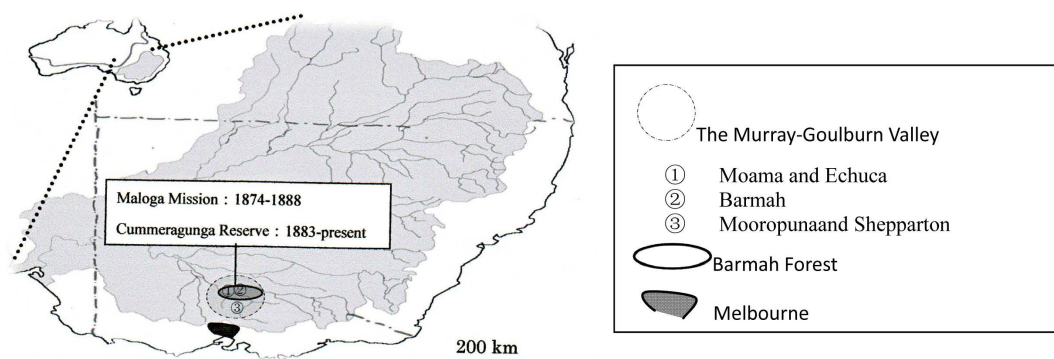


Figure 1. Study area: Murray-Goulburn Valley.

controversial issue among the Australian citizens and academics and then, state governments in Australia become enforced many measures for environmental protection. Under the circumstances, some practical measures such cooperative and joint management with the indigenous people for the environmental protection in the Murray-Goulburn Valley has been set [8]. Therefore, indigenous peoples in the area have a political voice for the negotiation on the forest and river management with local, state and federal governments without any denial at present.

3. State of Water Quality for the Goulburn Broken Catchment (1995-2010) [9]

Figure 2 shows a Goulburn Broken Catchment area. The area of the Catchment is 24,310 km². And, **Figure 3** shows a Goulburn River basin. Red numbers show the river reaches. The water sampling points in this time are shown in this figure. Furthermore, **Figure 4** shows the water quality monitoring sites by the authority in the Goulburn River region. According to the Goulburn River Water Monitoring Report 1995-2010, a summary regarding the water quality (Turbidity, Electrical Conductivity (Salinity), Dissolved Oxygen, pH and Phosphorus) for the Goulburn Broken Catchment is as follows [10]. **Table 1** shows the summary of the state of water quality (1995-2010) for the Goulburn Broken Catchment briefly.

Therefore, it can be said that efforts need to be made by the people centering on the community residents to avoid the deterioration of Total Phosphorus at present.



Figure 2. Goulburn broken catchment [10].

Table 1. State of water quality for the Goulburn Broken Catchment (summary).

Water quality items measured	State of water quality
1) Turbidity	The value of Turbidity is temporarily high by the influence of fire at the upper reach. But, it progresses toward recover after 2007.
2) Electrical conductivity	The value of Electrical conductivity is in fairly in good excluding two or three sites of the creek.
3) Dissolved oxygen	The value of Dissolved oxygen is in fairly in good at the all sites.
4) pH	The value of pH is in stable in the basin.
5) Total phosphorus	The value of Total Phosphorus shows the deterioration at almost all sites since the end of 2009 and almost all sites are rated as "Poor" or "Degraded" in 2010.

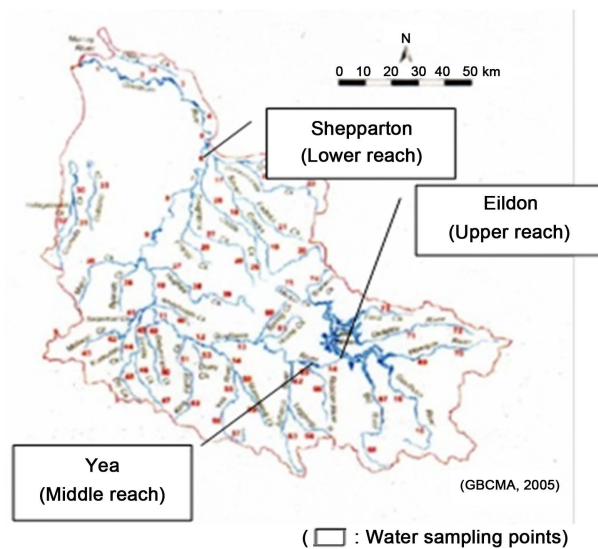
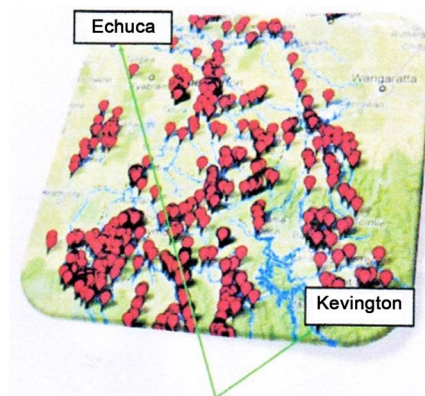


Figure 3. River reaches in the Goulburn River Basin [10].



The Goulburn River at Kevington is the most upstream site, and Echuca is the most downstream.
(Red mark: Water quality monitoring sites)

Figure 4. Water quality monitoring sites by the authority in the Goulburn River region [10].

4. The Approach for the Water Quality Conservation by Visualization of Water Quality—A Proposal of Water Quality Mapping at Water Resource Area by Sound Waves

Authors have carried out the experiment on the improvement of water and waste-water treatment process using various sound waves (frequency) including ultrasonic wave [11] [12]. Specifically, various sound waves such as 1) ultrasonic wave; 2) music box and 3) wind-bell were irradiated to the six kinds of the water such as drinking water (hard water/soft water), forest water (upper reach/middle reach/lower reach) and sea water for removing contaminants such as nitrate, phosphorus and BOD/COD. The conclusion of the paper is as follows [12].

- 1) Various sound waves affect on the improvement of the water quality.
- 2) As for the removal rate of NO_2^- and NO_3^- concerning to the three samples such as the sea water, drinking water and the forest water, high values (>50%) were obtained, respectively.
- 3) PO_4^{3-} was also confirmed to decrease more than 50% in the forest water.
- 4) BOD and COD were drastically decreased especially in drinking water and forest water.
- 5) The removal rate of Ca^{2+} and Mg^{2+} was also large (>50%) in the drinking water. Along with these, TH also drastically decreased. On the other hand, Na^+ , K^+ and NH_4^+ showed very few change.

6) Therefore, decrease of NO_2^- , NO_3^- and PO_4^{3-} are due to the reaction with bivalent cations of Ca^{2+} and Mg^{2+} rather than monovalent cations such as Na^+ , K^+ and NH_4^+ .

7) It is supposed that if hard water with components of Ca^{2+} and Mg^{2+} are properly added into a soft drinking water, and the sound waves are irradiated to them, NO_2^- , NO_3^- and PO_4^{3-} could be reduced. It could be useful from the industrial viewpoint.

Furthermore, from the results mentioned above, a possibility of the improvement of water quality by murmuring sound of a natural stream was suggested [13] (Figure 5). If such a phenomenon may occurs, it is confirmed that natural purification mechanism could work. This is a subject for the near future.

Then, an environmental anthropological consideration of watershed management based on the sounds (frequency) was undertaken considering whether water quality management due to the sounds can be conducted or not in this study. This time, Goulburn river basin in the southern part of Australia was selected as an objective catchment area. One of the selected reasons is that the management of this basin has been carried out by the indigenous Australians (Yorta Yorta people) for quite a long time so far. The water sampling points in the catchment area are shown in Figure 3. And, the ultrasonic waves that are the easiest way to operate among the sounds were selected as an irradiated sound (frequency). The result of irradiated ultrasonic waves into Goulburn river water is shown in Table 2. As is seen in Table 2 and Figure 6, a result of the water quality improvement of Goulburn River shows almost the same tendency as the case of Inukai River in Japan (12). Regarding nitrogen (N) and phosphorus (P), as the concentration of water quality at the sampling points (upper reach, middle reach and lower reach) was not detected, the values of the substances could not be obtained this time. It is estimated that if there exist some concentration in the river, an effect of improvement will be expected. As is seen in Table 1 (The state of water quality for the Goulburn Broken Catchment), the most important thing is that just only phosphorus (P) in the river reduces. Therefore, it is suggested that there will be a possibility of expecting the water quality improvement using sound waves including murmuring sound in the Goulburn River. Figure 7 shows an image picture on mapping of water quality by residents living in the watershed. If the residents will practice the water quality mapping, as a result, a conservation of water resources for drinking water will be expected through the recognition of the three factors, that is, 1) visualization → 2) awareness → 3) circulation of connection.

Table 2. Experimental results of Goulburn River water sample.

Substances	Goulburn River		
	Eildon	Yea	Shepparton
	(Upper Reach)	(Middle Reach)	(Lower Reach)
pH	7.5 → 7.0	7.5 → 7.0	7.5 → 7.5
TH (mg/L)	10 → 0	10 → 0	20 → 35
COD (mg/L)	8 → 3	8 → 3	13 → 10
BOD (mg/L)	4 → 3	4 → 3	5 → 2
NH_4^+ (mg/L)	0.26 → 0.26	0.26 → 0.26	0.26 → 0.26
NO_2^- (mg/L)	0.033 → 0.017	0.033 → 0.017	N.D.
NO_3^- (mg/L)	N.D.	N.D.	N.D.
PO_4^{3-} (mg/L)	N.D.	N.D.	N.D.
Ca^{2+} (mg/L)	12.5 → 8.5	12.5 → 8.5	15.6 → 8.8
Mg^{2+} (mg/L)	4.1 → 8.2	4.1 → 8.2	14.3 → 14.3
Na^+ (mg/L)	4.0 → 4.4	6.7 → 6.6	12.0 → 11.0
K^+ (mg/L)	0.9 → 0.9	1.4 → 1.5	2.1 → 2.3

N.D.: not detected.

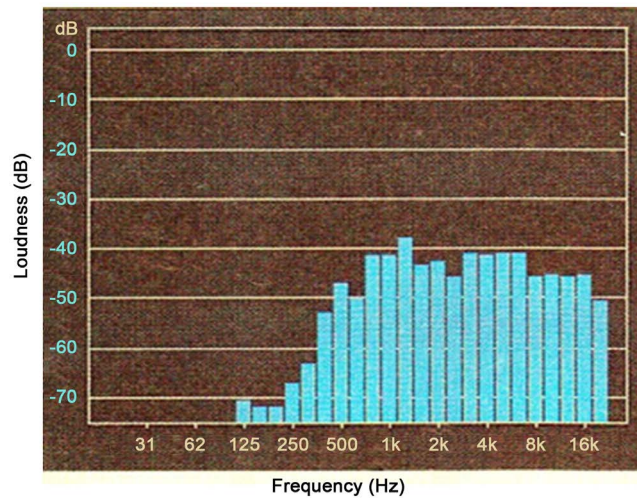


Figure 5. Example of frequency analysis of murmuring sound of stream [13].

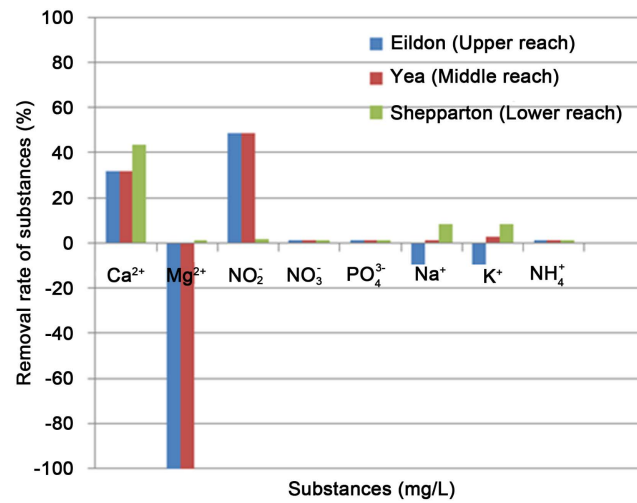


Figure 6. Removal rate of substances.

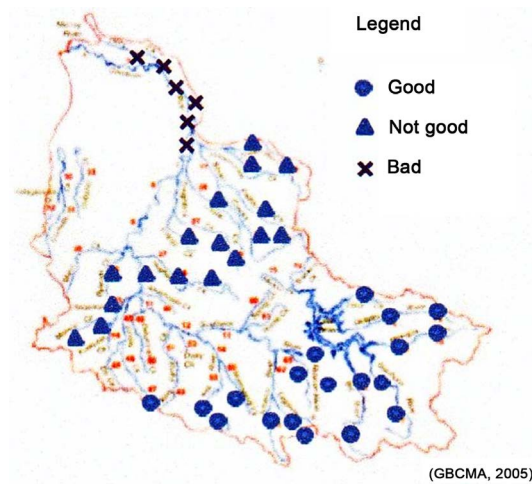


Figure 7. Mapping of water quality by residents living in the watershed (image picture).

5. Thought of FUBEN-EKI (Further Benefit of a Kind of Inconvenience) [14] Environment-Social Systems

In this chapter, we think how we do the content of Chapter four toward the sustainable thing for the resident living in the basin. Here, a thought of “FUBEN-EKI Environment-Social Systems” which is very important in considering “sustainability” is described.

5.1. Bi-Directional Connection between Forest and Humankind Linked through Community Currency (Environmental Tax)—Construction of Values-Driven Management

First of all, it is claimed that the sending out of the following statement, that is, “Environmental conservation is incompatible with an economic growth and we should not make environmental conservation compatible with an economic growth [15] [16]” is the most important thing for solving environmental issues. Because the economic growth is based on the rent, and on the other hand, the environmental conservation is due to the ethics, respectively. That is to say, the basic principle of the former is the independence and that of the latter is the autonomy, essentially. Then which should we prioritize, the environmental conservation or the economic growth? If we think the economics is a frame of governing a nation and providing relief to people, the rent based on the money that one pay regularly for the use of land, a house or a building should be prioritized. In Japan however, there is a voice of anxiety for the situation “Environmental studies is prosperous; yet environment is ruined” [17]. So if economics is prosperous; yet country (nature/environment) is ruined, we have got our priorities wrong. In Japan, on the other hand, there is a proverb saying that “the country is destroyed; yet mountains and rivers remain.” [18] We interpret this proverb as follows; the country (social system) is ruined, which means the artificial creations are surely extinct; yet the recoverable environment is still remaining. And we are sure that our country will be prosperous. As we mentioned above, environmental conservation and an economic growth are incompatible with each other. But even if the country (social system) is ruined, we can recover the environment by conservation activity again. However, if “economics is prosperous yet country (nature/environment) is ruined”, then we can’t recover our country. Environmental conservation (Owner: “God” which indicates the existence of an ultimate mental entity behind the universe = Owner does not exist. Not existed) is an obligation (responsibility). This is defined in the basic environment law in Japan. How can we utilize the environment? Then a concept of a rental fee to use the environment comes out. As for this, in general the existence of the user (people, company) and the owner (administration; country, city etc.) can be considered temporarily. However, a possession of the management (approval of management costs) is necessary to maintain the situation of utilization sustainably/forever.

5.2. Introduction of Community Currency (Environmental Tax) and Its Use—Planning of Environment Investment Strategy for Which Becomes a Mortgage of Sustainability

In the context of a possession of the management mentioned above, a thought of cost-benefit comes out. We use both of them as the following meanings. That is, the cost here has a meaning of doing the management expressly, that is, “sacrifice” which shows the meaning of “Kosten” in German language, and the benefit has a meaning of a favor we can use freely forever. Therefore, we think that there is a responsibility as the obligation for conserving the environment. For that, a thought of the necessity of betting money (investment) comes out. As for the investment, there are three features as follows ; 1) To be very good at appearance (to have a correspondence ability); 2) To be able to realize a return; and 3) To be able to use the eco-money. As for return (\neq profit, margin), useful good (good 1, good 2, good 3) as a social return comes out. A medley of those goods is environmental goods. This is called wealth. The wealth becomes full. Then, such a situation could lead to an increase of affluence (a scale of measuring the providing of relief to people). This “affluence” is just saying the worth of a nation (environmental affluence as a good), does not give the time value of currency not at all. Therefore, the currency should be used without interest. Furthermore, as for the use of eco-money (without interest) as money to spend, although this one is accompanied by an inconvenience (FUBEN-EKI) [14], it is effective for environmental conservation. There are three reasons why we use the eco-money: a) Constant & Long term (Eco-money is kept constant sustainably); b) Unreasonable (Do not be seized with common sense) and c) Non-boom (Do not boom) (see [Figure 7](#)). From the above, the important thing in the thought of FUBEN-EKI [14] environment-social sys-

tems is fundamentally based on the composition of a strife between “rent” and “ethics.” As for rent, there are diverse rents as shown in the word “different” (a compound word between differ and rent). But strife should persist in abiding by the ethics. At present, there have been loudly called for SR (Social Responsibility), but this means a strife to abide by the ethics. From expressing in a line of connection of this sentence, SR accrues to us at the situation to keep (utilize) FUBEN-EKI [14] in an unchanged condition. We think that this is a foundation of a thought of environment-social systems in watershed management.

6. Orderly Use of Forest and Water Resource Management

6.1. Recent Trend of the Amount of Domestic Water in Use in Japan

Figure 8 shows the recent trend (1991-2010) of the amount of domestic water in use in Japan [15]. It can be seen from this figure that the amount of domestic water in use keeps on decreasing since its peak in 1997 in Japan. And, it is said that the citizens who drink a tap water as a drinking water are on a declining trend of 30 percent of the whole in Japan (Tokyo) [15]. **Figure 9** shows the amount of production and import for the PET-bottle in Japan. It can be seen from this figure that the PET-bottle as a drinking water is on an increasing trend year by year. It is thought that this decreasing trend of the water consumption has a possibility of a correlation between the citizens who do not use it as a drinking water and the trend. In addition to that, it is said according to the prediction of the long term trend of the total population in Japan that the decrease of the total population will become conspicuous since its peak in 2004 [19]. When looking at these trends, there is still some doubt about making the purified water (drinking water) abundantly using the rapid filtration in the future. When considering about the decrease of the population and the maintenance (including the countermeasure of chlorination) of the water pipe and so on, the continuous use of the present purification system (rapid filtration process) in the future is bring about the possibility of causing the high cost. On the other hand, the maintenance of the slow sand filtration becomes easy, and cost is relatively cheap to use the treatment at minimal disinfection cost. And, considering that the quantity of water does not matter appreciably with the decrease of the population, the slowness of the filtration speed does not matter. So it is thought that the effect of the purification by the creatures will be expected for that. In general, the slow sand filtration can widely remove pollutants in comparison with the rapid sand filtration. And it is thought that the both sand filtrations are realistically difficult to remove the Nitrate-N from the point of view of cost effectiveness in the future. Therefore, it is thought that the possibility of removing the fundamental pollutants by only slow sand filtration will be high if we could carry out the conservation of the water resource area sufficiently and sustainably.

6.2. Slow Sand Filtration

Slow sand filtration (ecological purification system) has been developed in the UK around two hundred years ago (see **Figure 10**). We get the drinking water with safe, cheap and delicious natural water using this method.

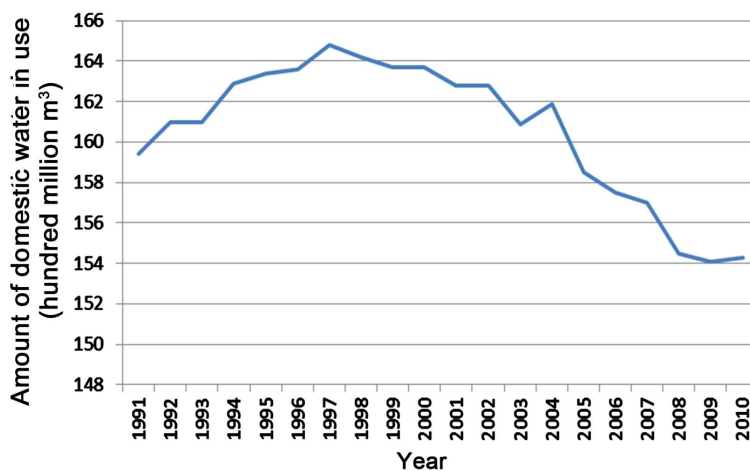


Figure 8. Changes in amount of domestic water in use (1991-2010) [15].

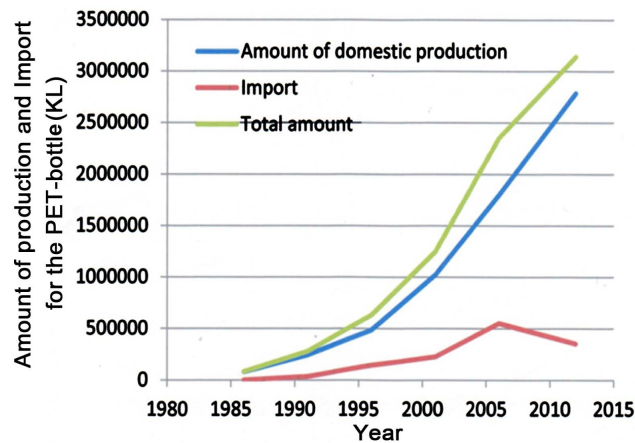


Figure 9. Changes in amount of production and import for the PET-bottle in Japan (1986-2012) [16].

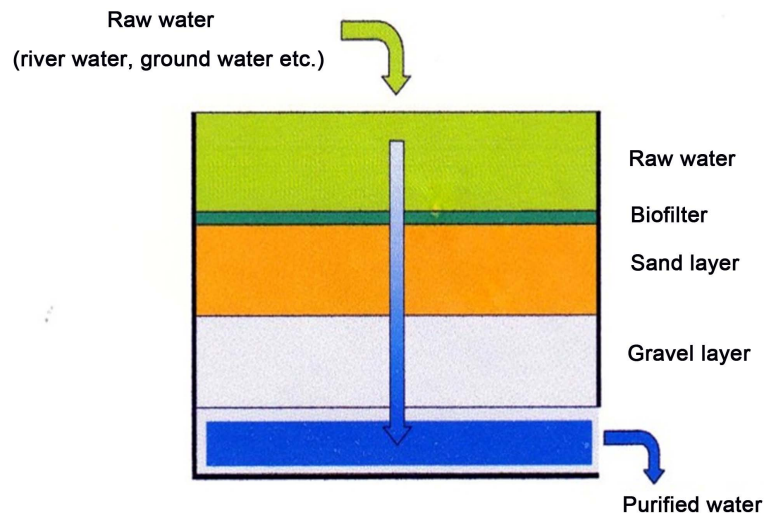


Figure 10. Schematic diagram of water purification mechanism by slow sand filtration [12].

The point of this method is just only through the raw water in the sand layer slowly. This is based on the idea (hint) that natural springs at the foot of mountains (forests) water and the riverbed are very pure. This system has once thought that the raw water is purified by just only physical filtration. The fact that the raw water is purified by the microbial action etc. has clarified around 100 hundred years ago. **Figure 11** shows a schematic diagram of water purification mechanism by slow sand filtration [12]. When passing the raw water into the slow sand filtration bed, a bio-filter by all microorganisms etc. is naturally formed on the sand layer. The raw water is purified by the microbial action etc. in the filtration bed. It is also described by N. Nakamoto as follows. “Slow sand filtration is not simply a physical filtration process. Drinking water can be produced with an ecological purification system. Biological activity in slow sand filtration is the key to producing safe and delicious drinking water. Biological activity is the basis for safe and delicious water. Algae, small animals and microscopic organisms are all important for ecological purification systems. It is emphasized that this is not simply a physical filtration process and is an ecological purification system. And, it is also stated that biological activity is the key to produce good drinking water. That is, organisms are very important for ecological purification systems. In this system, even bacteria can be removed by biological activity. On the other hand, there is no removing in rapid sand filters because of the big size of sand grain. By the way, it is often said that Japan is a mountainous country. The 70% of land of Japan is occupied by the mountainous area. Therefore, it is very easy to find spring water. Some springs have delicious water which is not only no treatment but also no relation to the chlorination. Natural



Figure 11. Eco-money to be used for conserving the water resource (image picture).

springs at the foot of mountains are delicious because of the water purified by natural processes. There are selected good water quality regions called “MEISUI 100 SEN” which was selected by the Environment Agency in Japan (1985). The criteria for selection (two essential conditions) are as follows. 1) Existence of good condition from the view point such as water quality, water quantity, surrounding environment, affinity for water. 2) Existence of conservation activity by community resident. But, the water resource area has gradually deteriorated in the region which is not sustainably active in the conservation of water environment. As a result, the region which cannot be called a MEISUI (good area for water quality) from the view point of “drinking water” is gradually increased [20]. Therefore, a construction of the wholesome environmental social system on the conservation of the water quality of water resource area is urgently required. On the other hand, rapid sand filtration plant consists of rapid sand filters, sedimentation tanks and chemical mixing basin in general. Although the area of rapid sand filters is small, a large area is necessary to sludge handling. Therefore, this system is fast indeed, but requires the treatment of large amount of the sludge as an industrial waste which is discharged from the plant every day. The cost of the treatment is getting higher than that of the water treating. That is, sludge disposal is expensive and troublesome. All microorganisms etc. cannot live in a rapid filter system and chemical reagents such as coagulants in the rapid sand filters are fatal to the creatures. It is said that chlorination was enforced by American military in Japan. They say that chlorinated tap water is not safe. However, it is said in London that non chlorinated tap water is the best water to drink. In general, the phrase “Chlorinated tap water is toxic to fish” is now common knowledge in the world. A problem on cryptosporidium flowed from the cattle pastures around a reservoir which is the water source occurred in rapid sand filters at an earlier time. But in the case of slow sand filters, cryptosporidium was not dangerous at all.

6.3. Role of the Forest as Slow Sand and Alternative Biological Filtration Equipment in Natural World

As mentioned above, this slow sand filtration holds good traditional technology even today in the world. This technology is old, but also thought wise use of natural steps for human life. Thorough investigation on the relationship between murmuring sounds and water quality in the mountains (forests), we have to learn the importance of the role of the forest in natural world. Colin Walker, who is an elder of the Yorta Yorta Aboriginal group, told the meaning of river and forest. “Our lakes, we got Barmah lake and Moira lake. When you look at the map, it looks like the living things because lakes look like kidneys and river running down through the lakes in the middle were the spine. If you look at properly you will see it looks like human body. Little creeks through running into the forest look like veins. Veins on the water get on the running in purifying the lakes just our vein, our body, and our blood. That is purified by two lakes as the kidneys” (Walker, C. Interview with Y. Tomonaga, his house at Cumeragunga, March 24 2008) (see [Figure 12](#)). In connection with this, there is a unique book entitled “Toward Water Reuse: Learn It from Your Own Body (1976)” written by Dr. Isu. Kyu [21]. In the case of the Yorta Yorta, they have been seeking their authenticities through making the “Land Use and Occupancy Map” supported by Canadian specialists since 2006. The aims of this map are the following; firstly, it lets Australian society acknowledge the Yorta Yorta as Traditional Owners on the river and forest; second it delivers social, economic, environmental and cultural outcomes for the Yorta Yorta and; third it gives the Yorta Yorta opportunity to get partnerships based on respect, honesty, and capacity to participate equally, with shared responsibility and clearly defined accountability and authority (see map in [Figure 12](#)). The Yorta Yorta collected around 6600 sites as their cultural and spiritual significance from 66 respondents and they trained six coordinators for cultural map who have responsibility to record their traditional and living knowledge of forest and river into the map and take the living knowledge over the next generations. The use of this information will be utilized by the YYNAC to negotiate outcomes in relation to natural resource management, in particular environ-

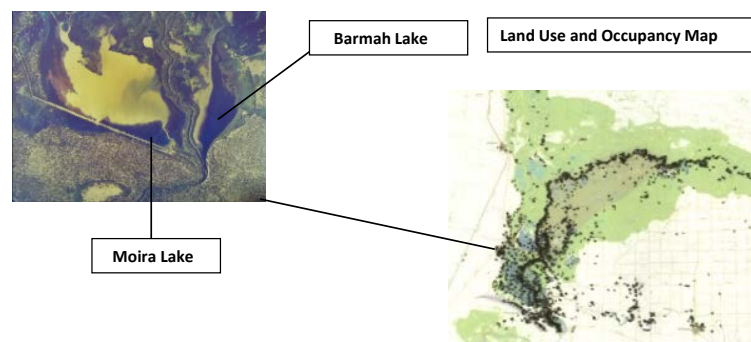


Figure 12. Barmah forest as human body.

mental management plans, watering plans with a view to establish discussions with government regarding Yorta Yorta's right to have allocations of cultural water to return water flow to the areas that need it the most to encourage the spawning of fish and other species and therefore ensure their existence for future generations of Yorta Yorta people.

7. Conclusions

In this paper, an environmental anthropological study of watershed management regarding water quality conservation of forest as catchment area in the southern part of Australia was conducted. As a result on the human activity contributed to the water quality conservation, the importance of constructing FUBEN-EKI (Further Benefit of a Kind of Inconvenience) environment-social systems and the management of water resource based on the slow sand filtration imitated the filtration of forest were recognized respectively. The concluding remarks are as follows: 1) The proposal toward a water quality conservation of watershed/forest as a catchment area is as follows; In the water quality conservation, the value change/consciousness change for water are needed. For that the recognition of the three factors (visualization, awareness and circulation of connection) is very important for water. "Visualization of water quality" as an incentive for the effort of the conservation of catchment area is effective. In concrete, we consider that the mapping of the catchment area water quality by the sounds is appropriate; 2) And the approach required in contrast with the independent effort of water quality conservation driven by the watershed community residents is as follows; eco-money (environmental tax) is effective as a standard currency toward bi-directional connection between man and the forest. Using this money, it is possible to construct the values-driven management. Regarding the introduction and its use, we think that the planning of the environment investment strategy (the practical business administration of the environment) for which becomes a mortgage of sustainability is very important.

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