Problem Solving for Stable Water Intake on Community-managed Water Supply System in Ojiro Village, Umegashima District, Headwaters Area of Abe River, Shizuoka (Japan)

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Abstract: In Japan, approximately 2,600,000 people (2% of Japanese population) were not included in the public water supply area. In this no public water supply area, self-managed water supply system is using by community even now. In this paper, a case study of community-managed water supply system on Ojiro Village where is located in head waters area of Abe River, Shizuoka, Japan is discussed. Ojiro's community-managed water system sometimes cut-off water by any troubles. Therefore, in 2017, the local residents and our university team carried out a re-construction of new intake system. This paper aims to show a relationship between new intake water quantity and a condition of trouble occurrence. For this purpose, two water level loggers set on the new intake from Nov 2017 until now, to measure a water quantity of in-flow and out-flow. Data collected every two months and analyzed water level related with rainfall and trouble occurrence timing in each season. Based on this result, the efficiency of new intake was evaluated.

Keywords: Water supply system, Community-managed, Trouble of intake, Intake and flow, Headwaters area, Shizuoka, Japan

1. Introduction

The water supply system as an administrative service is one barometer of modernization. In 1950, the water supply system in Japan covered only 26.2%. Rural and remote areas used surface streams, springs and underground water, its. In 1978, during the period of high economic growth, the water supply system achieved 90.3%. In 2017, it covered 98.0%, and most people used tap water via water supply system controlled by the local government (Ministry of Health, Labour and Welfare, 2019a). However approximately 2,600,000 people (2% of the Japanese population) did not have the benefit of this water supply region (Ministry of Health, Labour and Welfare, 2019b).

Geologist Osamu Shinmi described the no-water supply area as a self-managed water community: as follows; "Some self-managed water community is do not need the public water supply system. These communities can get rich water from the spring and ground water by themselves. Therefore, self-water supply communities were established based on each environment" (Shinmi, 1989). This paper will focus on the no-water supply areas and show community-based practice by case studies. It will treat the no-water supply area as autonomous community through managing everyday water needs by local residents.

The following will be discussed: Section 2 explains the natural and geographical conditions of the Abe River basin and outline of the Umegashima District; Section 3 showes the case practice for improved water intake system by community power in Ojiro Village; Section 4; discusses self-water management and community independence for problem solving; Finally, section 5 concludes the study.

2. Abe River basin and Umegashima district

This section explains the outline of the research areas. Umegashima is located in the headwaters area of Abe River basin (Fig. 1). Therefore, we will need to discuss the natural environment and history of the Abe River basin when explaining the case site, Umegashima.

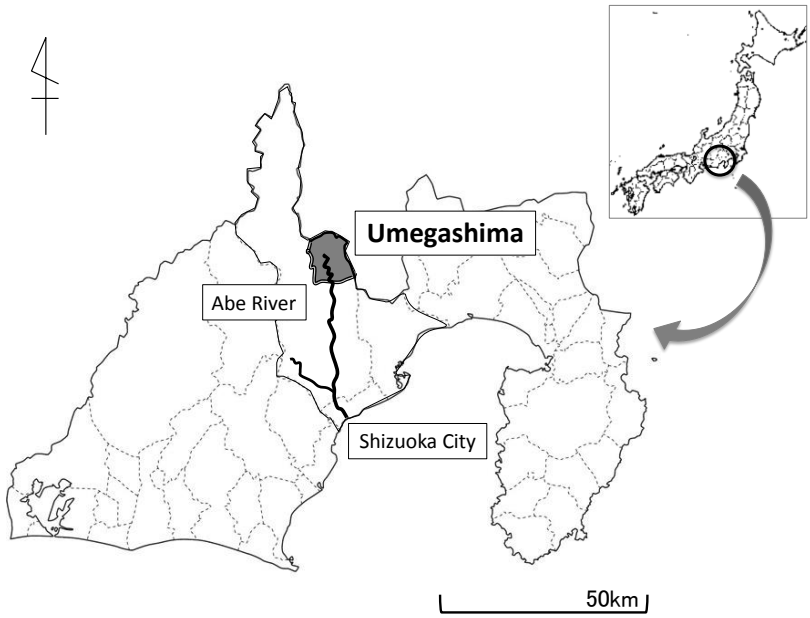

Fig. 1: Umegashima District in Shizuoka Prefecture, Japan
Source: Author

Outline of the natural and geographical conditions of the Abe River basin

Abe River originates from Oya Rei (1999.7 m max altitude at) in the upper Umegashima District, the northern most part of Shizuoka City. Abe River flows into Suruga Bay after flow in through in the Shizuoka city area. Abe River is a Class A river with a main river line of 51 km and basin area is 567 km^2 (Ministry of Land, Infrastructure, Transport and Tourism, Chūbu Regional Development Bureau, 2008).

Abe River is called a steep slope and direct type river (also a Tokai type river). In the normal conditions, running water flows from small stream water to wide river-width, but in periods of heavy rainfall, the muddy stream increase to the fullest river width. The Abe River has a more rapid slope bed, classified "a river of rapid stream and sediment outflow" (National Land Agency, Land Bureau, National Land Survey Division, 1988).

The geological character of the Abe River basin is fragile. Most of land in this basin belongs to the Setogawa group that is mainly composed of shale. Shale is a sedimentary fine grain rock, composed of clay, silt and mud and similar to aqueous rock. It has a fine laminae structure and character is split easily (Suzuki, 2005). This river basin is affected by the Sasayama tectonic line on the West and the Itoigawa-Shizuoka tectonic line and Jumai tectonic line on the East. Therefore, this basin's stratum is sometimes altered by earthquakes.

Shizuoka Plain in the city area was made from the sediments from Abe River. The underground Shizuoka Plain is formed a thick gravel layer that cultivates abundant ground water. For example, the Suruga Ward (by south of Shizuoka Plains, on the entire south side of Shizuoka city) can get all tap water needs from groundwater. Seventeen deep wells (including two reserve wells) can intake 71,900m^3 / day (Shizuoka City Waterworks Bureau, Water Service Department 2018).

Outline of the Umegashima District

Umegashima District is located in the mountainous area 50 km from the central part of Shizuoka City (Fig. 2). Total land area of Umegashima District is 92.27 km^2, 93 % is a mountainous area (Umegashima board of education, 1968). The entirety Umegashima area does not receive water supplied by local government. Therefore, the community organize small-scale water supply cooperatives by themselves to secure water.
From an administrative point of view in 1889, Umegashima Village absorbed Nyujima Village. In 1969, Umegashima Village was absorbed into Shizuoka city and became a part of the Aoi Ward. Umegashima district consists of from nine communities. Fig. 3 shows a population transition in Umegashima. In 1891, 190 households and 1,142 people lived in Umegashima. In the peak year in 1955, 346 households and 1,855 people lived there. However, the population began to rapidly decrease after 1955, with only 157 households and 385 people living there in 2019. Compare with the peak year in 1955, the decreasing rate of the households is 51.16%, and the decreasing rate of the population is 79.41%. The number of present population and households are less than when Umegashima village was started in 1889 (The Ministry of Construction, Shizuoka River Construction Office, 1988).

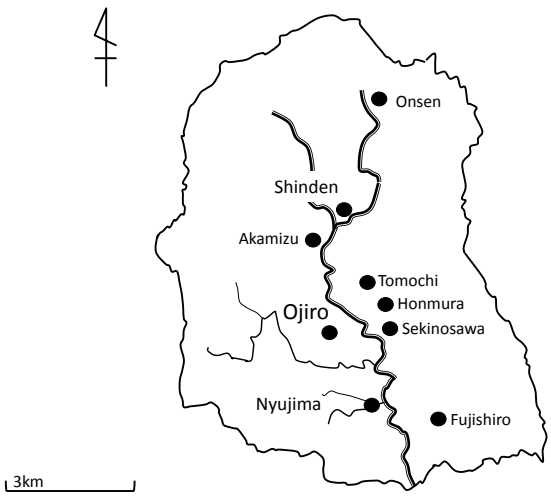

Fig.2 Community of Umegashima
Source: Author

Fig. 3: Population in Umegashima
Source: Author

Note: This graph was based on the records of population statistic (The Ministry of Construction, Shizuoka River Construction Office, 1988 et al.)

Ⅲ. Practice actions for problem solving in Ojiro

Outline of community practice in Ojiro

In this section, a case study of community practice for water supply management in Ojiro will be explained. Ojiro village is located in 800 m altitude mountainside area. At present, 10 families and 34 people are living there. The aging rate is 47.05% in 2019 (Umegashima self-government association union, 2019). Almost all residents work in agriculture (Tea and Mushroom, Wasabi), civil work and forestry.

Taking water from the maintain surface stream, in the mountain Fukasawa, began 1932. A water supply system was integrated in 1966. This cooperative continues to work together even now. Daily management of water supply system is operated in rotation by 7 residents. These residents improved their skills to solve the troubles of the water supply system by themselves. But now, they face some problems. The distance from the village to its water source (called MIZUMOTO) is 1.7 km on the mountainous road (called MIZUMICHI). The Intaken water from the water source in Fukasawa flows through a pipeline underneath MIZUMICHI to the 10 ton capacity head tank which is located at the top of Ojiro village. At MIZUMOTO, local residents have constructed intake facilities (Fig. 4). There are 3 intakes and 2 water tanks, but these facilities have some troubles, therefore, Ojiro residents and our team started to work together and carried out construction work in 2017 to build new intake facilities in MIZUMOTO.

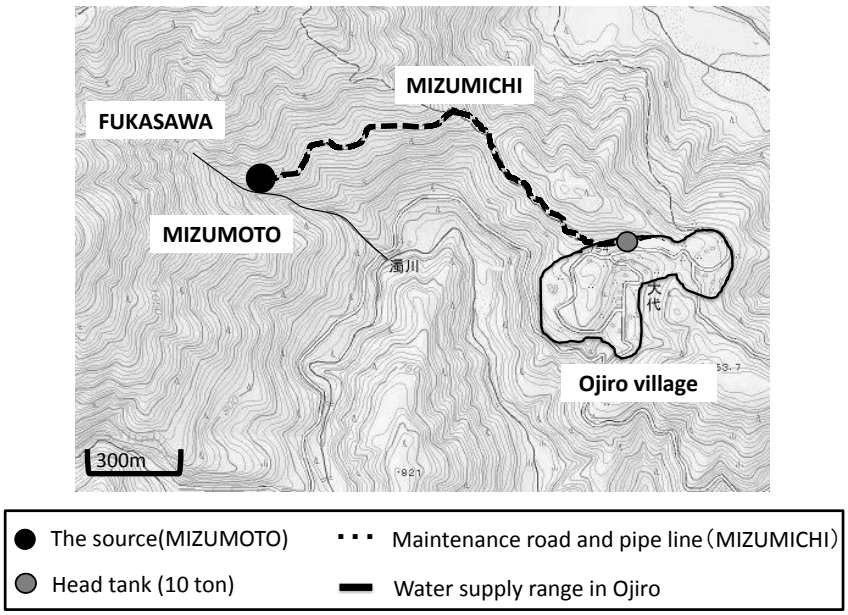

Fig. 4: Sketch map of Ojiro water supply system
Source: Author

Past actions for problem solving (from 2014 to 2017)

Intake trouble occurshad caused in once a month. A member of the cooperative recorded troubles and maintenance work on water supply facilities since 1985. In 2011, problems occurred 24 times in a year. On average, issues occurred 11 times a year within 30 years. The

rotation maintenance system is operated by the male members only. However, residents and members are getting older year by year.
We have held discussions since 2014 to reach a consensus of how to rehabilitate the water supply facilities as follows: first, how to reduce the number of maintenance check year; second, how to transform the intake structure for easy management. Residents in Ojiro come to an agreement: “There is no longer any need to seek a new intake: We, the Ojiro residents, will improve the present water supply system.”
We was a collaborate research to check and maintain MIZUMICHI, which was damaged by a landslide. In November 2015, we had worked together to repair MIZUMICHI, because to keep secure the road to MIZUMOTO is the most important thing for maintenance work. From April 2016, the authors and a university student team took part in cleaning works in MIZUMOTO. “MIZUMOTO Intake Cleaning Manual (periodically updated)” was made to share the implicit know-how in residents .
Since February 2017, the construction plan meetings have made progress in reaching a consensus and deciding the design of new intake. We carried out experimental surveys at the site once a month from February to September 2017. At the same time, we had workshops to finalize the design of improvement intake, and to set the construction schedule .
On November 17th, 19th and 26th, 2017, Construction work was carried out with more than 30 people. Local residents provided at least one worker from each household. The construction work proceeded as follows; First in 17th, we started to bring materials from the village to MIZUMOTO. In MIZUMOTO, two keyresidents of construction had worked for adjustment and assembly of the molds. They had confirmed and adjusted each mold to fit on configuration and build in reinforcing bar as support frame for concrete. On 19th, all household took part in the construction work to assemble new intake. On 26th, after concrete had harden, mold was removed, and we checked flaw into new intake (Fig 6).

Fig. 6 New intake
Source: Author (June 9, 2019)

New actions for problem solving (from 2018 to 2019)

In Ojiro, the new intake technology inspires new ideas. The new intake is a vast on the former one. After construction, started to survey measure inflow and outflow of surface water about new intake and continues to monitor some problems about the water supply systems. As same as, the part of trouble change from intake to first head tank (Fig.7). The residents had been tried improvement action for head tank trouble. Residents’ charenges separate to three stages in 2018 to 2019. In this period, we caried out survey and collected data on every two months.

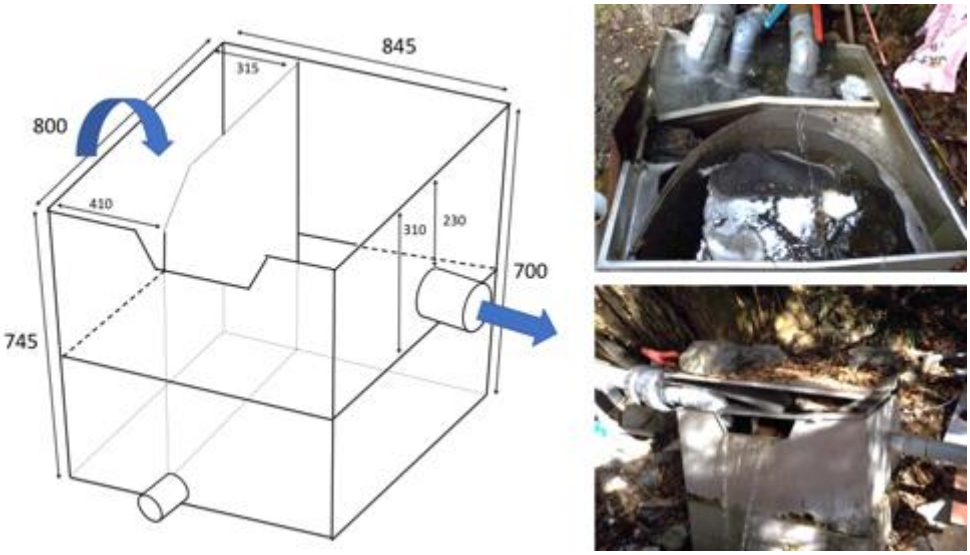

Fig. 7 First head tank
Source: Author

First stage is March to November in 2018. In March, local residents tried to make a new trap filter for leaves. It was set up inside of head tank as a follow-up effort to improve the flow. But new trap filter haven't enough ability for blocking troubles. Leaves and mud cloged on filter's opening because leaves flow directly to filter. Residents thought the way of not directly stuck the leaves and mud on filter. They added one more filter on outside of this in May. Second filter is made by plate-like stainless mesh and formed to cover the first filter. It blocked some leaves on surface of flow, but some fine dust through out and stucked first filter (Fig.8).

Fig. 8 First filtter and second filter
Source: Author (July 5, 2018)

Second stage is November 2018 to May 2019. In October 2018, our team reported middle result of the survey in community meeting in Ojiro. We shared and discussed actual condition of MIZUMOTO and MIZUMICHI. In November 2018, we did maintenance of MIZUMICHI and periodic survey with two residents. We shared real condition of intake and head tank in

MIZUMOTO. Through this action, we suggested common practice that accompany and participate in periodic survey with key-person of management in Ojiro. One resident of key-person agreed this suggest, also he suggested cleanup work at the same time and participate in survey from February 2019. Since then, he had been thought the way of solution to problem together. We discussed condition of intake and head tank with flow of water, he also thought or discussed condition and after improvement with other key-person. In May 2019, residents centered on key-person, they acted to set a new filter (third filter) on top of other filter. This filter is used insect screen that is used in Wasabi farm (Fig.9).

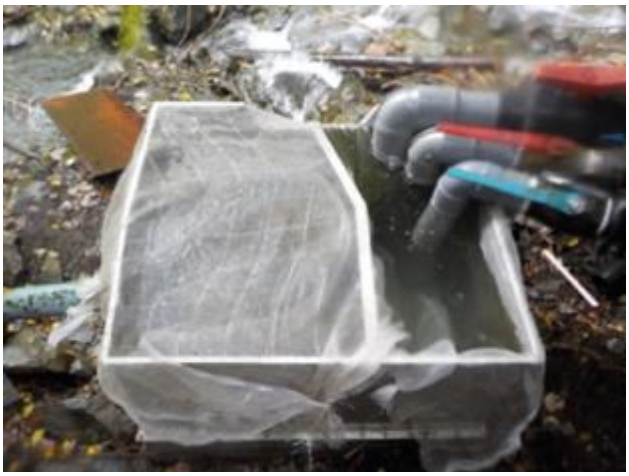

Fig. 9 New filter (third filter)
Source: Author (October 20, 2019)

Third stage is since May 2019, residents test caused trouble reduction with periodical clean up work in every two months. From May 9th to October 12th, water cut off trouble had never happened. Residents understand good effect of test filter through by their daily life and our survey team report. We reported in community meeting and shared condition about inside of head tank on June and October 2019. Based on this, residents have became to formulate new management and maintenance ways in village.

4. Discussion: Meaning of collaborative work for community water supply system in the future

This rehabilitating the community water supply system indicates that the local history of community building continues to the present day. For example, Ojiro water supply cooperation continued from the old residents work from 1932. We are taking another look at the work of previous residents and getting the idea to rehabilitate construction work by community power. Each household member took part in the construction work and established the water commons of the community. This work is not private but making ‘public’ consciousness for all residents. These cooperative works were shared experiences of implicit knowledge and know-how. For example, some residents in Ojiro took each handiwork tool based on civil work and forestry work experience. During construction, resident members were of some generations. The intake and water supply facilities continue to keep and rehabilitate over generations. The experience and record are common resources to manage the water supply system for the next generation.
To illustrate the meaning of shared water inside Ojiro, this water supplies the fire station as well as community facilities. Water is not a private but a community resource. It means that a case of Ojiro water supply cooperatives supply to field campus (activity base that is kept by stocks and all in vacant house). Residents who are sharing community water are conscious of imagined community protecting themselves.

5. Conclusion

This paper gave attention to the local water supply system apart from the definition of water supply enterprise based on the water works law. Through research and case studies in Umegashima, there are community-based practice for self-managing water supply system by community cooperatives. It is clear that local residents have made on independent local water system sustainable by their own hands. The daily practice of managing the water supply system empowers local residents against disaster and other dangers. Community independence is supported by actions to obtain everyday water by themselves. The residents can be self-reliant through the maintenance work in MIZUMOTO and MIZUMICHI.
Local residents started to tackle to these next problems by themselves. They continue to think and work together today. It is the first step to socio-technical challenge to make a sustainable community in mountainous remote areas of in Japan.

Acknowledgement
This research was supported by JSPS KAKENHI (Grant-in-Aid for Early-Career Scientists) Grant Number 18K14538 and Organization for Innovation and Social Collaboration, Shizuoka University.

Reference

Fujimoto. Tokihiko and S.Ito (2018a). Jinkō gensyō no sankanchīki ni okeru “syūraku suidō” mondai: Abekawa genryū-iki no shizuoka-shi umegashima-chiku no chōsa kara [A Research on Independent Water Supply Cooperatives of the Upstream Area in Abe River, Shizuoka, Japan]. S*yakaikankyōronkyū [Studies on Social Environment]*. 11. Tokyo: Association for Social Environment Studies. 51-74

Fujimoto. Tokihiko and S.Ito (2018b). Suidō wo syūraku de ijisuru toha donoyōna itonamika: Shizuoka-shi umegashima ojiro chiku deno “syūraku suidou” wo mamoru jissen kara [Sociological Approach to the Management System of the Independent Water Supply in the Mountainous Community: A Case Study of the Upstream Area in Abe River, Shizuoka, Japan]. *Shizuoka daigaku syōgai gakusyū kyōiku kenkyū [Bulletin of the Center for Education and Research of Lifelong Learning, Shizuoka University]*. 20. Shizuoka: Education of Regional Development Center, Shizuoka University. 3-13.

Toshiharu, Harada (1986). Jūmin ga tukutta jōsuidō: Toshika to kumiaisuidō [Water works of made by residents: Urbanization and association water supply]. *Chiri [Geography]*. 31-2: Kokonsyoin. 124-130.

Institute of Climate Engineering attached to Fuji Tokoha University. (2003). *Abekawa sabō jōryūiki hūdo tokusei chōsa gyōmu hōkokusyo. [The Report of Research Work about Climate Characteristic in Upstream area on Erosion to Abe River]*. Institute of Climate Engineering attached to Fuji Tokoha University. 6.

Sanoko Ito, R.Itsukushima and T.Fujimoto (2018). “Syūraku suidō” wo mirai ni tsunagu kōji: Shizuoka-shi umegashima ojiro chiku ni okeru jūmin syutai no shakai kiban seibi [A Construction Record of the Community Works of Grated Bottom Intakes for the Sustainable Independent Water Supply System in the Upstream Area in Abe River, Shizuoka, Japan]. *Shizuoka daigaku syōgai gakusyū kyōiku kenkyū [Bulletin of the Center*

for Education and Research of Lifelong Learning, Shizuoka University]. 20. Shizuoka: Education of Regional Development Center, Shizuoka University. 15-27.

Japan. The Ministry of Construction, Shizuoka River Construction Office. (1988). *Abekawa sabō-shi [Record of Erosion Control in Abe River]*. Shizuoka: The Ministry of Construction, Shizuoka River Construction Office. 29-31.

Japan. Ministry of Health, Labour and Welfare. (2019a). *Suidō no kihon tōkei, Suidō hukyūritsu no suii* [*Basic Satistics of Water supply, The Transition of Water Supply Coverage Ratio]*. https://www.mhlw.go.jp/content/000501640.pdf

Japan. Ministry of Health, Labour and Welfare. (2019b). *Suidō no kihon tōkei, Genzai kyūsui jinkō to suidō hukyūritsu* [*Basic Satistics of Water supply, The Present Water Supplied Population and Water Supply Coverage Ratio]*. https://www.mhlw.go.jp/content/000501640.pdf

Japan. Ministry of Health, Labour and Welfare. (2019c). *Shin-suidō vision ni tsuite [About New Water Supply Vision]*. https://www.mhlw.go.jp/seisakunitsuite/bunya/topics/bukyoku/kenkou/suido/newvision/1_0_suidou_newvision.htm

Japan. Ministry of Land, Infrastructure, Transport and Tourism, Chūbu Regional Development Bureau. (2008). *Abe-kawa suikei kasen seibi keikaku (Daijin kanri kukan) [River Improvement Plan of Abe River System: Section Directly Administered by MOC]*. Nagoya: Ministry of Land, Infrastructure, Transport and Tourism, Chūbu Regional Development Bureau. 1.

Japan. National Land Agency, Land Bureau, National Land Survey Division. (1988). *Abe-kawa, Oi-gawa, Kiku-gawa chīki syuyō suikei chōsasyo. [Report of Main River System on the Area of Abe, Oi and Kiku rivers]*. Tokyo: National Land Agency, Land Bureau, National Land Survey Division. 11.

Japan. Shizuoka City Waterworks Breau, Water Service Department. (2018). *Shizuoka-shi suidō jigyō no aramasi [Outline of Waterworks in Shizuoka City]*. Shizuoka: Shizuoka City Waterworks Breau, Water Service Department. 7.

Japan. Shizuoka prefecture, Life and Environment Department, Environment Bureau, Water Use Section. (2019). *Shizuoka-ken no suidō no genkyō, 5. Inryō sui kyōkyūshisetsu [The Present State of Waterworks in Shizuoka Prefecture 5. Small-Scale Water Supply Facilities]*. https://www.pref.shizuoka.jp/kankyou/ka-060/suidougenkyou.html

Ojiro Water Supply *Cooperative*. (2017). *Ojiro jōsuidō: Jōsuidō tōbanchō [Ojiro Watereorks: Waterworks Diary]*. Ojiro Water Supply *Cooperative*. (Retrieved May 31, 2017).

Atsushi,Sakurai (1986=1991). Kawa to mizu: Mizu to shakai no hendō [River and Water Supply: A Change of Water and Society]. *Mizu to hito no kankyō-shi: Biwako kankyō hōkoku [Environmental History of Water and Human: Environmental Report of Lake Biwa]*. Eds. Hiroyuki Torigoe. and Yukiko Kada. Enlarged edition. Tokyo: Ochanomizu Syobou. 163-204.

Osamu, Shinmi (1989) Nomimizu to chīkisei [Drinking Water and Regionality]. *Chiri [Geography]*. 34-8: Tokyō: Kokonsyoin. 29-30

Toshio, Suzuki (2005). Hekigan [Shale]. *Ganseki jiten [The Dictionary of Rock]*. Tokyo: Asakura syoten. 179

Masahiro, Tabeda (1987). Okinawa-hontō no "Mizumondai" ni kansuru ichi-kōsatu: Onnamura no kanisuidō sonpai mondai wo tyūshin tosite [A study on the problem of water

supply in okinawa Island: A case study of the ware supply system in Onna village]. *Syoukei ronsyu [Jornal of Business and Economics]*. 15-2: Okinawa International University. 67.

Umegashima Board of Education. (1968). *Umegashima sonshi [Record of Umegashima Village]*. Umegashima village office. 1., 17-18.

Umegashima Self-government Association Union. (2016). *Chōnai betsu jinkō chōsa ichiranhyō [The Table of Research to Population by Small Community]*. Shizuoka*:*Umegashima Neighborhood Association.

*Last Access URL; 5DEC2019