Traditional development of water conservation based on local knowledge: coping with climate change impacts in rural areas

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Abstract. The aim of this research is more to understand how to local people in strengthening the capability of water scarcity to availability, mainly in hilly areas is the one place that susceptible to climate change impacts, which drought is the one problem on the dry season in rural areas. The “Jamban systems” is the one model type developed as adaptation process in meeting the demand of family or social community-scale, which each of the people tried of taking advantage water scarcity optimally, where they were tried to be managed of the water scarcity in the surroundings of their dwelling finely and continually. A qualitative research study and purposive sampling were used to data collection, alongside reinforced by the direct observation and in-depth individual interview method, which were at least 25 respondent and it’s based on ecosystem types. The result of this research shown that the most of local people have utilized water kindly, optimal, and sustain in their alive, which it’s also optimized used to water scarcity by employing of type, alongside its part of adapting and mitigating process to climate change impacts dynamically.

1. Introduction
Climate change impacts are factual and its global trend [1], that impacts of climate change brought to many of disaster to vulnerabilities to food insecurity, water scarcity and loss of livestock was facing by rural areas, but it also to be one of the biggest challenges or problems at local to global scale [2]. Climate change impacts influenced the future of biodiversity, which it’s leads to the loss of biodiversity occurrence [3]. The climate change is global problems, but locally that the water scarcity is part of the impact of climate change, so many of the local people suffered because of loss of water availability, mainly in hilly of rural areas. The other side that the hilly is one area that has multipurpose of ecological functions [4], comprised of the catchment area, framer of local weather, keeper of high biodiversity, and so on. Therefore sustaining and maintaining water resources is necessary to pay attention seriously, mainly to the local people in the hilly areas, where it’s susceptible to drought caused by climate change impacts. Therefore, creating and developing adaptation type has been taken that must do it, to survive on water scarcity that caused by climate change impacts.

In a rural area, where the local people have difficulted in the water supplying to their farmland, and livestock, therefore the “Jamban systems” is the one approach, which supposedly was used to cope with climate change impacts in which hopefulness to local people survive on water insufficiency occurrence. Managing water scarcity based on local knowledge is the key role in water conservation paradigm, and it is part of the richness of rural areas tradition related to sustainable [5,6]. Water conservation is pivotal in supporting the ecological function and sustainable development paradigm achieved. Maintaining and sustaining water resources is a must [7], so the establishment of water conservation buildings must be
realized. This case is a part of response on the human activities (anthropogenic) that it has impaired, so the water conservation actions by economizing and ecological ought to do in the framework of sustainable development paradigm, which one could be managing of water resources continually and everlasting in espousing of the human beings or welfare.

Preventing of water scarcity based on local wisdom is part of adjusting and alleviating to climate change impacts, which one the Jamban systems type developed and it’s traditional of water conservation type based on local perspective [5,8], also it has held a key role of importance to rainfed agriculture and the others. Refers to these problems, in this research tried to discussing about how to adapt of local people in coping to climate change impacts, mainly in managing of water scarcity aspects in their daily, in meet a demands of family or communities-scale?, and how many to advantages of Jamban systems developed in a rural areas, chiefly in Cikolang village where the local people depends on water when in dry season (drought)?

2. Methods
Cikolang is a part of Tasikmalaya Regency in administrative (Figure 1), West Java, Indonesia. It is famous as Sunda ethnic and community, in which their living still depends on natural resources potential. Geographically, the Cikalong areas is hilly type, which has reputed as a conservation zone, with elevation 100–500 m asl. Land use changes in Cikalong was an occurrence, where altered forest to agricultural land was immensely, so directly it would be affected to water availability, therefor in this research endeavored to comprehend local people’s view about multifunction of Jamban systems in their alive so long as.

This research has started from August – October 2019, which qualitative data was used to analysis, alongside the stratified random sampling was used to data collection based on elevation gradient and its ecosystem type, afterward to records of environments typical that comprised (agricultural, residence, forest, and so on). There are some respondents used to data collection process, which at least 25 respondents, which it would be used to data analysis and its data sources or qualitative data in this research, then the social-ecological approach was used to descriptive analytic to a scientific narrative developed in this research, and it’s supported by processual analysis approach. The respondents have classified to some of the criterion, they were: (a) personage, (b) the farmer, and (c) public society of surroundings.

Figure 1. Administrative map of research of site
3. Results and discussion

They’re some of the earnings in the village as like to Cikalong, Tasikmalaya Regency, West Java, where Cikalong areas is a hilly type of ecosystems, at moment in dry season they would be threatened to water scarcity (drought). The Jamban systems is water conservation type to sustainability goals, alongside utilizing of water scarcity by optimal and efficient is a part of adapt to strategies type in meet a demands of family-scale, especially water supply, this pattern reputed able to social resilience systems by take advantage of watershed by sustainable, so many of local people have had utilized of the Jamban systems to increase the welfare goals (figure 2, 3 and 4).

3.1. Traditional of water management developed to water conservation

This study discovered the modified method to prevent water scarcity optimal and efficiently by the local people in Cikalon village, Tasikmalaya Regency, West Java, which called as Jamban systems. It is an alternative solution in response to water-scarce, during dry season from August to November. During dry season, the drought occurs, hence water scarcity become problem that confronted to local people. These cases would be considered to climate change impacts related, [9] also it impacted to uncertainties of season (rainy and dry season), so directly it impacts to water supplies, so they are trying to cope by well methods or Jamban systems developed.

Most of local people keeps on make serious efforts in water management by employing types (figure 3), alongside with figure 2, illustrating how the local people take opportunity of water scarcity by optimal to the human being attained [10]. Commonly, Cikalon is the hilly areas and experiences water scarcity, where drought is one of phenomenon that attacks violently to the human being, so it needs strategic solution [11,12]. Direct observation through in-depth interview and FGD could become the strategy to mitigate and adapt to drought, Therefore the knowledge of severe to floods and its droughts has desired of a tools in coping it [13], especially in the hilly areas that vulnerable to climate change impacts, which that water harvesting methods were considered able to supply water by sustain [8,12].
The water conservation methods by Recycle and Reuse paradigm [14] or it based on their experience of local knowledge [15], gradually the local people started of water management kindly, although traditional technic approach in Jamban systems developed (figure 4). This method is one of solution alternative in copying of water-scarce, so the needs of a pay attention to all side, that water resources would be threat of the human existence, if not response and shifting of behavior to more friendly in the human-nature relationships dynamically, particularly relate to managing the sustainability of watershed. Therefore, clean water process and the usage to supply for human being in their living become important, and must be realized. The water supply is needed to the human health and it's wellbeing to social resilience of systems achieved [16].

Figure 3. Utilizing of watershed kindly and optimum, including of (A) Culinary station, (B) Water availability to farmland, (C) to growth and development of plants, (D) strengthening of wood (bamboo)

3.2 Conserving of water scarcity to human wellbeing
Utilization of watershed is one step in coping with water scarcity in which the village at the hilly areas that confronted with the loss of water resources caused by the human activities unfriendly in changing of land use dynamics and illegal logging and of course its part of one adaption to climate change impacts. In Cikalong areas is one of the example areas that could be illustrated, how the local people have done to manage watershed by efficiently and optimum, alongside it’s a part of learning learned the process in understanding of natural dynamic [17]. On figure 2, illustrated how the local people able to manage of watershed continually and efficient based on Re-use and Re-cycle paradigm [14], so gradually and
slowly lead to social resilience system in water supply, although in dry season (drought), which the water is essential in supporting to economic activities and developed in rural areas, for example of farmland (cropland), aquaculture of fish, and forth, that the humans at the global has changes of land transformed, which at least 50% have modified [18] to economic unfriendly, so it has broken to water scarcity occurrence [19], therefore many of local people tried to collecting and saving water in their surroundings, but only if used to activities daily as like to wash of motorcycles and forth by sustainable (figure 2).

Discussing the water resources is very complex and dynamic, where aced on the human activities impacts the existence of water cycles, which one of the problems in rural or urban areas is local sources of pollution and indirectly lead to reduce of ecosystem services [18,20]. Therefore, it needs to pay any attention to overcoming it, which are local knowledge and local authority hope to problem-solving efficiently and effectively to clean water and sanitation, if all of the sides could be worked by good, synergies, and compact, which there some of the steps ought to do in obtaining of clean water and sanitation are functional, accountable, transparent, inclusive and free of corruption, and able to coordinate with each other [21].

![Figure 4. Jamban type developed, included to (A) Jamban systems behind of dwelling, (B) Jamban system in the middle of farmland, where is used to water availability to farmlands.](image)

The water cycle of traditional perspective development, which would have been considered of water management type developed in the framework to the water conservation process. The building of water conservation by local people involved has become one strategy that is created to the human-nature relationship friendly and continually, so created to the hardness of water supply type, although in dry season occurrence. These matter supported to [22] explained that in facing to drought caused of climate change impact by increased to capability in managing of drought finely and continuously, where Cikalong areas indirectly or directly able to cope it, by Jamban systems developed, so this type is part of response in preparing of climate change impact to drought, alongside in water supply to crop productivity supported, and considered of adaptation processed [23].

4. Conclusion
The Jamban system is the one of traditional water conservation type developed in a rural area, where it has considered to response of water scarcity dynamically, alongside it is a strategy to meet family or
community-scale demand to aquaculture, crop on water, submerge of wood, water availability to farmland, and forth. The multifunction of Jamban systems developed by the local people are able to the welfare and part of steps to the response to climate change impacts kindly by efficient, effective, and dynamic in which systems could be advantaged for the local people continually and sustainable.

References
[1] Nyahunda L, Trivangasi M H 2019 Challenges faced by rural people in mitigating the effects of climate change in the Mazungunye communal lands, Zimbabwe Jamba-Journal of Disaster Risk Studies 11 596
Zwane M E 2019 Impact of climate change on primary agriculture, water sources and food security in Western Cape, South Africa Jamba-Journal of Disaster Risk Studies 11 562
[2] IPCC 2007 Climate change 2007: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change ed M L Parry, O F Canziani, J P Palutikof, P J van der Linden, and C E Hanson (Cambridge: Cambridge University Press)
[3] Bellard C, Bertelsmeier C, Leadley P, Thuiller W, and Courchamp F 2012 Impacts of climate change on the future of biodiversity Ecol. Lett. 15 365-377
Walther G R 2010 Community and ecosystem responses to recent climate change. Phil.Trans. R. Soc. B 365 2019-2024
[4] Grét-Regamey A, Brunner S H, and Kienast F 2010 Mountain ecosystem services: Who cares? Mountain Research and Development, Supplement Issue 32 10.1659/MRD-JOURNAL-D-10-00115.S1
[5] Sharma N and Kanwar P 2009 Indigenous water conservation systems A rich of rural Himachal Pradesh Indian Journal of Traditional Knowledge 8 510-513
[6] Behailu B M, Pietila P E, and Katko T S 2016 Indigenous Practices of Water Management for Sustainable Services: Case of Borana and Konso, Ethiopia Special Issue-Traditional Wisdom, SAGE Journal pp 1-11 10.1177/2158244016682292
Iniesta-Aranda I, del Amo D G, García-Nieto A P, Piñeiro C, Montes C, and Martín-López B 2015 Factors influencing local ecological knowledge maintenance in Mediterranean watersheds: Insights for environmental policies AMBIO 44 285-296
[7] Le T A, Wyseure G, and Hoang V L 2004 Sustainable water management for rural development in the Mekong river delta, Vietnam The Second International Symposium Asian Water Environment (Hanoi, 1-3 December 2004)
[8] Rockstrom J, Karlberg L, Wani S P, Barron J, Hatibu N, Oweis T, Bruggeman A, Farahani J dan Qiang Z 2010 Managing water in rainfed agriculture-The need for a paradigm shift Agricultural Water Management 97 543-550
[9] Macdonald M A, Calow R C, MacDonald D M, Darling W G, and Dochartaigh B E O 2009 What impact will climate change have on rural groundwater supplies in Africa Hydrological Sciences Journal 64 690-703
[10] Hunter P R, Macdonald A M, and Carter R C 2010 Water supply and health PLoS Med. 7 e1000361
[11] Hassan A G, Fullen M A, and Oloke D 2019 Problems of drought and its management in Yobe State, Nigeria Weather and Climate Extremes 23 100192
[12] Dharmarao S S 2016 Water harvesting – a solution to drought and falling level of ground water International Conference on “Emerging Research Trends in Applied Engineering and Technology” (India: Konkan Gyanpeeth College of Engineering, Karjat)
[13] Alho C J R and Silva J S V 2012 Effects of severe floods and droughts on wildlife of the Pantanal wetland (Brazil): A review Animals (Basel) 2 591-610
[14] Beekman B G 1998 Water conservation, recycling and reuse International Journal of Water Resources Development 14 353-364
[15] Audefroy J F and Sanchez B N C 2017 Integrating local knowledge for climate change adaptation in Yucatan, Mexico International Journal of Sustainable Built Environment 6 228-237
Kettle N P, Dow K, Tuler S, Webler T, Whitehead J, and Miller K M 2014 Integrating scientific and local knowledge to inform risk-based management approaches for climate adaptation Climate Risk Management 4-5 17-31
Anik S I and Khan M A S A 2012 Climate change adaptation through local knowledge in the North Eastern region of Bangladesh Mitigation and Adaptation Strategies for Global Change 17 879-896
[16] Chaurasia S and Towari A 2016 A review on traditional water purification methods used in rural area Indian Journal of Environment Protection 36 43-48
[17] Tabaram J D and Pahl-Wostl C 2007 Sustainability learning in natural resource use and management Ecology and Society 12 3
[18] Hooke R L, Martin-Duque F, and Pedraza J 2012 Land transformation by humans: A review GSA Today 22 1-7
[19] Liu J, Yang H, Gosling S N, Kummu M, Florke S, Hanasaki N, Wada Y, Zhang X, Zheng C, Alcamo J, and Oki T 2017 Water scarcity assessments in the past, present, and future Earth’s Future 5 545-559
[20] Hering J G, Sedlak D L, Tortajada C, Biswas A K, Niwagaba C, and Breu T 2015 Local perspectives on water SCIENCE 349 479-480
[21] Tortajada C and Biswas A K 2018 Achieving universal access to clean water and sanitation in an era of water scarcity: strengthening contributions from academia Current Opinion in Environmental Sustainability 34 21-25
[22] Solh M and van Ginkel M 2014 Drought preparedness and drought mitigation in the developing world’s drylands Weather and Climate Extremes 3 62-66
Wilhite D A, Sivakumar M V K, and Pulwarty R 2014 Managing drought risk in a changing: the role of national drought policy Weather and Climate Extremes 3 4-13
[23] Quiroga S and Suarez C 2016 Climate change and drought effects on rural income distribution in the Mediterranean: a case study for Spain Nat. Hazards Earth Syst. Scu. 16 1369-1385A3S45678H9JKS,6U7.,