The local knowledge to mitigate the landslide disaster in Beruk village, Jatiyoso sub-district, Karanganyar regency

S A Cahyono1*, A Wuryanta1, and CY Lastiantoro1

1Watershed Management and Technology Center, Ministry of Environment and Forestry, Jl. Jend. A. Yani Pabelan-Kartasura, Central Java, Indonesia

sandycahyono@yahoo.com (ORCID ID: 0000-0001-5609-7575)

Abstract. Local knowledge is an essential aspect of mitigating hydrometeorological disasters. The purpose of the study is to identified local knowledge of landslide disaster mitigation. The study was conducted in Beruk village, Jatiyoso sub-district, Karanganyar regency. The topography of the Beruk village area was dominated by hills and mountains with an average slope of above 30°. The research was conducted using a descriptive-analytic method. Landslide mitigation strategies based on local knowledge were determined using a SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis. The results showed that in areas with potential landslides, which are characterized by the appearance of soil cracks, the community removes the soil that has the potential for landslides to other places so that it reduces the slope load, and changes the way of cultivating horticultural crops by using a model of mounds, nyabuk gunung (mountain belt), gotong royong, plastic mulch, and mist sprinkler irrigation. The results of the SWOT analysis showed that strategies to overcome weaknesses and take advantage of opportunities are conducted by (1) increasing the quantity and capacity of Human Resources (HR) of horticultural cultivation institutions in the field, and (2) observing landslides with gotong royong.

1. Introduction
Disaster is a general term for events that give devastating effects on human beings and the environment where they live [1,2]. Indonesia is one of the countries with an enormous potential for disasters [earthquakes, landslides, floods, droughts, and social conflict] [3,4], so it is often called a "disaster supermarket country" [5-8]. Crises and disasters give opportunities to the community to learn and transform toward improving disaster risk reduction and resilience [9]. One of the most common natural disasters in Indonesia is landslides [8,10]. Landslide is a movement of slope-forming material in rock, debris, soil, or a combination of these that moves down or out of the slope. For this reason, an effort is needed to reduce the risk (mitigation) of landslide hazards like reducing casualties and losses, especially in areas with steep slopes. Law No. 24 of 2007 concerning Disaster Management [11] defines mitigation as an effort to reduce disaster risk through physical development, awareness, and improved capability to face disaster threats.

The National Disaster Management Agency (BNPB) categorizes landslides as the deadliest hydrometeorological disaster. Several landslides were caused by very high rainfall intensity [12]. Karanganyar regency, specially Jatiyoso sub-district is a landslides-prone area [13]. As an example, the landslide disaster that occurred in Beruk village, caused bridge damage, community isolation, death, losses, road access closure, and disrupted the economy and life [14]. A month later (14/4/2021),
landsides occurred again in 41 locations, causing hundreds of millions of losses, evacuation of seven families [15], closures of road access, and disrupting the economy and life [14]. Most of the landslide locations were in dry fields (moorland) that were far from the settlements, so it did not cause casualties.

The study’s results of Land Potential in Beruk and Wonorejo village, Jatiyoso sub-district by Tim Sibermas (2008) stated that one of the obstacles to agricultural development in these village is the mountainous topography. Both of them have steep slopes so that the cultivation of food causes a landslide. The researcher recommends that the management of agricultural land that has a very gently sloping mountainous topography should continue to pay attention to aspects of land conservation, namely by making bench terraces, planting according to contour lines, and strengthening plants on the edges of the terraces. Conservation efforts must also pay attention to staple crops that can improve soil and land construction. However, this condition is worsened by land-use activities by farmers, who mostly plant seasonal crops without any conservation efforts by building bench terraces. The crops widely planted by farmers are corn, cassava, shallots, carrots, peppers, mustard greens, peas, cabbage, and perennials such are cloves.

Local communities in landslide-prone areas are often neglected in disaster mitigation because they have insufficient knowledge and ability to mitigate landslide disasters [16]. Conversely, if the community has knowledge developed by learning from landslides that occur and doing landslides mitigation, the impact of the landslide can be minimized. Although landslides often happen, the casualties are relatively few. Traditional local knowledge or local wisdom is one of the keys to landslide mitigation. As is well known, traditional local knowledge is similar to western science because it is based on accumulated observations. Thus, local wisdom is an important aspect in mitigating hydrometeorological disasters. The study aims to identify local knowledge to mitigate the landslides in Beruk village.

2. Methods
This research method used qualitative research with a descriptive analysis approach. The descriptive method is a problem-solving procedure that describes the state of the research object when the research is carried out based on the facts [17]. The research location was determined purposively in Beruk village, Jatiyoso sub-district, Karanganyar regency. The village is located in the upper part of Samin sub-watershed. The sampling technique of key informants was purposive sampling. The determination of other informants was carried out by snowball sampling based on information obtained from previous informants. SWOT analysis was used to determine the landslide mitigation strategy based on local knowledge. The data were collected through in-depth interviews, observations, and literature review. The data of this study were primary and secondary data. The primary data in this study were obtained directly from farmers by interview. The data obtained in the form of qualitative data is about farmers’ behavior in agricultural land management.

3. Result and discussion

3.1. Characteristics of research sites
Beruk village, located in Jatiyoso sub-district (Figure 1), is an agricultural area with an average elevation of 998 meters above sea level, low temperature, fertile soil, and suitable horticulture. Due to the natural condition in Beruk village, which is a hilly area, the location has a high risk of erosion. This makes Beruk village included in a conservation area whose land must be preserved. Most of the agricultural lands in Beruk village are sloping areas with terracing techniques following the contour lines. Farmers in Beruk village have experienced in land management. Efforts on soil treatment will affect changes in soil properties. The involvement of farmers is an essential factor in preserving the land. Several farmers explained that agricultural land management techniques in Beruk village were carried out from generation to generation.
Beruk village is an area that relies on the food crops (vegetable) agricultural sub-sector. Prices of vegetable commodities produced by farmers will depend on supply and demand conditions. One of these supply conditions is influenced by the high costs that farmers incur for the procurement of several agricultural productions facilities. One way to improve land efficiency is through an intercropping pattern. It is because the pattern optimizes the use of light, water, and nutrients, and also controls weeds, pests, and diseases, as well as improves soil fertility through N fixation from legumes and is a pathway to sustainable agriculture [18].

3.2. Local knowledge in landslide disaster mitigation
Natural disasters are events that are difficult to predict accurately. However, the signs of a natural disaster can be seen, felt, and anticipated. The local communities who live in areas that have experienced or frequently experience these events, can learn the signs of an impending disaster and mitigate them. Local knowledge is the knowledge that has been developed by a group of people or communities who live in a certain area for a long time [16,19]. This local knowledge usually comes from observation, experience, and analysis among local communities [20].

[21] reviewed environmental management literature and classified knowledge into three forms, namely, experiential/local knowledge (generated from personal and cultural experience), scientific knowledge (generated through formalized scientific methods), and hybrid knowledge (generated through learning and social integration). Local knowledge is developed through long-term observations and accumulations of personal experiences in natural environments. It is rooted in people’s daily lives and embedded in the social structures that may consist of a set of norms governing natural resources and land, provide emotional connections among people, and link to cultural values [22]. [23] use “local sociality” to describe the daily experience of the local community’s life. In addition to the accumulation of the past, local knowledge is dynamic because people must continue to be creative and learn to successfully adapt to changes. Thus, local knowledge is capable of transformation, adjustment, and assimilation as thinking evolves [24,25]. According to [24], local people do not live in isolation, and knowledge develops through experiences that could further develop into new forms of local knowledge. Local knowledge is “place-based” (rather than location-based), and it is characterized by being fluid and dynamic [26] as well as contested and hybrid [27]. Since all types of knowledge, including local knowledge, are socially constructed [27], the power to develop knowledge through experiences must be returned to the local communities so it can be expanded with scientific knowledge [28]. The social learning processes of knowledge integration create a new form of knowledge called hybrid knowledge [21,24]. Through the integration of local and
scientific knowledge [i.e., multiple pieces of knowledge that have been synthesized or that combine new information to existing knowledge], hybrid knowledge could reflect local interpretations and present collective interpretations leading to consensus [28,29].

The results showed that the local community had local knowledge of landslides disaster mitigation. This local knowledge is effective in reducing the impact of landslides [30,31]. The local knowledge and local wisdom are derived from the community's understanding and experience in dealing with landslides. The knowledge of niteni, niroke, and nambahake is the basis for developing community local wisdom [16]. Several studies have demonstrated that agroecological farming practices have improved the adaptive capacity of agroecosystems and reduced vulnerability to natural disasters, climate change impacts, and stresses and shocks of emerging environmental and economic systems [22,32,33]. The local wisdom of Beruk village, concerning the management of forests and the environment, is manifested in the form of prohibitions such as: prohibited to cut down trees carelessly, prohibited to cut trees on the banks or the edge and upstream of the river, as well as prohibited to build in the spring’s areas, steep lands, and near waterfalls. The local knowledge of the community as an accumulation of collective experiences from generations needs to be preserved and developed to manage agricultural land/plantations and the environment [3]. The local knowledge in mitigating landslides in Beruk village include:

3.2.1 WhatsApp group-based disaster information system. Communication and information distribution are critical points for landslide disaster mitigation. At first, the communities used kentonangan, but it was less effective and efficient, so the communities used WhatsApp to communicate. According to [34], the existence of relationships in a centralized communication network among actors in this region greatly reduces disaster risk with local capacities. Then, [35] argue that there is a critical period when a disaster occurs, and in this period, the leadership is tested. The critical period requires the ability to make a decision correctly, quickly with the lowest possible risk. The response process starts immediately after a disaster occurs, and this period requires more complex actions than those for the mitigation, preparedness, and recovery phases.

3.2.2 Inspecting soil crack and reducing landslide loads. Communities carried out disaster mitigation and adaptation by checking for early signs of disaster and following the guidance. Besides, they are always in connect with relatives in other areas who gave an early indication of landslides [36]. One of the landslide mitigations carried out by communities is by observing the land condition. A special team is formed to inspect the conditions of the land, especially during heavy rains, by going around the village. Farmers also observe the land condition when they are in the field. If there are cracks in the land, they will inform the team about the conditions. Based on local wisdom/knowledge, the community can indicate that soil cracks are the indication of the beginning of a landslide. If there are soil cracks on the land, the communities will remove these cracks and reduce the soil load on the cracks. Communities move the potential of the soil landslides to other places to reduce the load on the slopes. This activity is done alone by a farmer when the crack is minor. However, if the crack is large enough and affects several farmers’ land, the farmers work together to move the soil until there is no soil crack. In Indonesia, there is traditional communal work for the community called mutual assistance or gotong royong [37, 38]. Gotong royong is an expression of harmonic desire, people awareness, and helpful intention to achieve common goals. This attitude is part of a tradition, value system, and local wisdom in the society. People living around the forest or mountain slope perform gotong royong to preserve and prevent environmental damage so that landslide disaster is evitable. Local wisdom may take form as principles followed, understood, and applied by the local society in their daily interaction and interrelation with the environment. It is formularized as a system of traditional values and norms, e.g., alon alon waton klakon (society of Central Java).

3.2.3. Tree planting. The location of this study has a reasonably steep topography and has a high potential for erosion and landslides. The farmers plant trees to mitigate landslides. [39] argues that
land control from soil erosion can be done by planting trees. Planting trees in conservation areas aims to protect the soil from erosion. The types of trees recommended to be planted are trees with deep roots, high crowns, and light mass. Trees that have deep roots help grip the soil, so it is not easily eroded. The light mass of trees aims to reduce the earth's gravitational force so that the tree becomes sturdy and does not fall easily. The recommended plants include pines, firs, palms, and coffee trees. In-depth interviews showed that farmers are aware of the benefits of planting trees, but farmers only want to plant trees in the village lands rather than in their agricultural land. Farmers only plant a few trees on cliffs that are difficult to cultivate for vegetable crops. Farmers believe that trees will reduce sunlight for growing vegetable crops. Some farmers based on their experience explain that tree in agricultural areas makes a decrease in vegetable production and farmers' incomes. On average, farmers in Beruk village have relatively small land, so that farmers must maximize their agricultural land to get more income.

3.2.4. Ground cover plants and grass. Ground cover plants in the form of grass help increase the ability of the soil to resist erosion and landslides. This plant protects the soil from raindrops, reduces surface runoff, and increases infiltration into the soil, thereby reducing erosion. The grass is always prioritized as an effort to preserve soil and prevent erosion and landslides because: (a) grass plants can grow quickly in a relatively short time, the soil can be covered by these plants, (b) the top of the grass can protect the soil surface from the impact of raindrops and slow down runoff, and the bottom of the plant can strengthen soil resistance and help facilitate water infiltration into the soil. Based on farmers' perspective in Beruk village, the grass keeps the soil from being eroded by water. The grass planting is also one of the methods used by farmers to substitute tree planting because it has the same function to protect the soil from erosion. However, grass will hinder the growth of vegetable crops if grass growth is not controlled. It will reduce the production of vegetable and farmers' income. Therefore, the grass is commonly found on bunds, bare land, and drainage or irrigation canals. To control the spread of grass, farmers routinely cut the grass for animal feed, especially cattle. Small land farmers usually do not have enough money to have livestock. If they have livestock, they need to feed their livestock with a lot of grass that cannot be fulfilled from their land. These small farmers work together with livestock owners to provide grass planted in their land. Landowners will take livestock compost for organic fertilizer for their crops. The synergy between landowners and breeders is a mutually beneficial symbiosis.

3.2.5. Soil processing according to contours and mounds. Land preparation by following contour lines or cutting slopes aims to reduce erosion and runoff. The main advantage of contour treatment is forming a runoff barrier that increases water absorption and prevents soil movement to control erosion. Farmers in Beruk village apply a tillage technique by following contour lines and calling it the "hill/mountain belt" (nyabuk gunung). Farmers know that this technique is inherited from generations for a long time, so they just need to continue their technique [40].

3.2.6. Use of mulch on agricultural land. Mulch is a layer of material used on the soil surface primarily to prevent water loss due to evaporation, or kill nuisance plants. The mulch is one way to protect the land from erosion and runoff. The mulch’s material can be divided into two types, namely, organic and inorganic mulch. Organic mulch comes from natural materials that are readily biodegradable, such as plant debris including straw and reeds while the inorganic mulch comes from plastic materials, usually called plastic mulch. Farmers in Beruk village use plastic mulch when they finish processing the land and are ready for planting. According to farmers in Beruk village, plastic mulch can inhibit the development of weeds that grow on agricultural land so that farmer’s energy and weeding costs become more efficient. In addition, mulch also serves to maintain the stability of soil moisture. The use of plastic mulch can overcome the nutrients leaching in fertilizers and soil due to rainwater. Splashing rainwater will be retained on the plastic mulch so that nutrients will not be leached by rainwater. Nutrients that are maintained can increase crop production to accelerate the
harvest time. Knowing these benefits, most of the farmers have used plastic mulch on their land. Farmers in Beruk village use mulch as a method to keep their land from landslides. Besides being suitable for plants, plastic mulch acts as a barrier to rainwater so that it does not directly enter the soil so that soil conditions will remain stable. The use of plastic mulch also reduces tillage. If not using plastic mulch, farmers usually processing the soil 3 to 4 times a year. Meanwhile, if using plastic mulch, soil processing is only done once a year. Other benefits of plastic mulch are to reduce costs and indirectly the level of soil erosion and landslides.

3.2.7. Irrigation system using sprinkler. The sprinkler irrigation system is an alternative method of giving water with higher efficiency of water delivery than surface irrigation. The sprinkler is used to spray water in the form of droplets like rainwater that falls to the land. The sprinkler is a plant irrigation technique that looks like rainwater that waters plants, which usually rotates automatically. The benefits of using the sprinkler are more time-efficient, water-safe, and soil erosion reduction. Sprinkler irrigation can increase the efficiency of water delivery by more than 80% [41]. According to an informant, the use of sprinklers has many benefits for agricultural land, namely time efficiency during automatic crop irrigation. Before using the sprinkler, farmers watered the plants manually. So it requires more extra time and energy. Whereas the needed time for watering the plants can be used to do other maintenance activities. The next benefit is to save more water. According to farmers in Beruk village, the sprinkler is considered more effective in spreading water for crop irrigation. Approximately 90% of farmers in Beruk village have already used sprinklers as a tool for irrigation on their land. The use of the sprinkler can reduce soil erosion because the irrigation process is only in the form of water splashes like rain that is evenly distributed. So that sprinklers can evenly distribute the water to plants and do not cause soil erosion and landslides.

3.3. Landslide mitigation strategy based on local knowledge
The communities and stakeholders of Beruk village have a strategy to develop their area that is prone to landslides by applying local knowledge that follows the times. The strategy analysis uses a SWOT analysis [42] and can be examined in Table 1.

3.3.1. Data collection stage. The data collection stage, namely evaluation of external and internal factors, can be examined in Table 1.

| Description of Internal and External factors | weight | Rating | Score |
|---------------------------------------------|--------|--------|-------|
| **1. Strength**                              |        |        |       |
| • Areas with an elevation of 1,000 meters above sea level is a natural tourist destination. | 0.35   | 4      | 1.4   |
| • Landslide management has been supported by the Central Government to the village. | 0.25   | 3      | 0.8   |
| • The ability of human resources in handling landslide areas and mutual assistance (gotong royong) is very good. | 0.40   | 4      | 1.6   |
| **2. Weakness**                              |        |        |       |
| • There is a lack of technical personnel for heavy equipment operations in landslide areas. | 0.50   | 1      | 0.5   |
| • The area of landslides is difficult to predict and difficult to reach (cliffs) | 0.25   | 2      | 0.5   |
| • There are inadequate facilities and infrastructures in reducing the risk of landslides. | 0.25   | 2      | 0.5   |

**The total score of Strengths - Weaknesses factor**

5.2
3. **Opportunity**
- Community support around the landslide area is strong. 0.35 4 1.4
- The demand for agriculture (vegetable) production and natural tourism/recreation services is increasing. 0.35 4 1.4
- The potential for productive and creative economic business/SMEs around the landslide area is quite large. 0.30 4 1.2

4. **Threat**
- Community dependence on agricultural farming results is high. 0.35 2 0.7
- The potential for damage to the area due to landslides, as a result of residential development is quite high. 0.30 2 0.6
- Landslides are still common. 0.35 2 0.7

The total score of Opportunity - Threat factor 60

---

**Figure 2.** Position of Beruk village

3.3.2. *Analysis stage.* Based on this analysis, a landslide management strategy in Beruk village was obtained to realize the following goal and objective: Possible positions and strategies types for Beruk Village that are suitable for taking advantage of opportunities and strengths. According to [42], knowing the position in the right quadrant can make more precise decisions. If the position is in quadrant, it means that Beruk village is very profitable and also has opportunities and strengths to take advantage of current opportunities. The strategy that must be implemented is strategy that support an aggressive growth strategy.

3.3.3. *Decision-making.*
1. Improving land cover quality, this strategy is carried out by maintaining productive lands and hilltops by implementing Forest and Land Rehabilitation.
2. Decreasing landslides disasters, this strategy is carried out by increasing the active role of the community in applying soil and water conservation principles and local knowledge.
3. Developing nature conservation management, this strategy is pursued by expanding environmentally friendly cultivation areas through developing fodder grass plants in landslide-prone areas.
4. Developing vegetable crops and livestock, this target is pursued through increasing cooperation with parties in the research and development of vegetable crops and livestock.
5. Providing environmental education services and nature conservation to students or the public, this effort is made to increase public understanding of nature and environmental conservation through collaboration with schools and universities that send their students for studies or research in this area.

6. Increasing the provision of tourism facilities and services for sustainable nature tourism, this effort is made to increase the provision of public facilities, communication of location information, viewing posts and visitor safety signs, as well as cooperation in utilization with other parties (travel agents) or the community.

7. Increasing the capacity of MSMEs (Micro, Small and Medium Enterprises), this effort is made to develop a productive economy and to increase the capacity of MSME human resources through training, comparative studies, and internships in the field of marketing and preservation of processed products made from cassava, as well as business management and creativity of various types of processed products.

8. Increasing the role of the community towards landslide-prone soils, this effort is carried out by developing social media like WhatsApp (WA) groups. Almost all community members use WhatsApp as a communication tool to broadcast warnings about landslides.

4. Conclusion
The community needs to have local knowledge to mitigate landslides in their area so that it does not become a landslide disaster. The local knowledge includes identifying landslide signs, reducing slope loads, providing direct information, and performing good cultivation to improve agriculture and reduce landslides. In areas that have the potential for landslides which are characterized by the appearance of soil cracks, community removes the soil that has the potential to landslide to other places to reduce the load on the slopes. This landslide can be reduced by using plastic mulch, sprinkler irrigation, nyabuk gunung and gotong royong. The results of the SWOT analysis show that strategies to overcome weaknesses and take advantage of opportunities are conducted by increasing the quantity and capacity of human resources and institutions in the field of horticultural cultivation, and observing landslides with gotong royong. The suggestion for this strategy is the need for increased coordination between the stakeholders and the people who live in the landslide area without ignoring local knowledge.

Acknowledgement
We would like to thank 1) Lanjar, a farmer who actively provides information about agricultural activities and landslide mitigation; 2) the head of Beruk village; 3) all staff who have given permission to conduct this research; 4) Slamet Eddy Sumanto as head of the Solo Watershed Management Technology Research and Development Center (BPPTPDAS), who has given permission to conduct the research activities.

References
[1] Peng L, Tan, J Lin, L and Xu, D 2019 Understanding sustainable disaster mitigation of stakeholder engagement: Risk perception, trust in public institutions, and disaster insurance Sustain Dev. 27(5) 885–97.
[2] Ma Z Guo, S Deng, X and Xu, D 2021 Community resilience and resident’s disaster preparedness: evidence from China’s earthquake-stricken areas Natural Hazards.
[3] Iskandar Andika T, and Wulandari 2021 The model of nonstructural mitigation policy to the landslide prone residential areas in Lebong, Bengkulu Yuridika 16(2) 333-48.
[4] Suryandari N W 2021 Environmental communication, local wisdom, and mitigation of Sampang flood Jurnal Komunikator. 2021;13(1):78-87.
[5] CNN Indonesia 2019 Kepala BNPB tak mau Indonesia disebut supermarket bencana Jakarta.
[6] CNBC Indonesia 2020 BNPB: Indonesia supermarket bencana, tapi jangan kecil hati. Jakarta.
[7] Infopublik.id 2020 Indonesia supermarket bencana. Jakarta.
[8] Kompaspedia 2021 Bencana alam di tengah pandemic Covid19 [Available from: https://kompaspedia.kompas.id/baca/infografik/kronologi/bencana-alam-di-tengah-pandemi-covid-19.

[9] Imperiale A J and Vanclay F 2021 Conceptualizing community resilience and the social dimensions of risk to overcome barriers to disaster risk reduction and sustainable development Sustainable Development1-15.

[10] Suwarini E, Afrina Fand Kurniawan E 2021 The level of threats and community capacity concerning to landslide emergency in Banjarnegara International Journal of Environmental Science and Development 12(4)118-25.

[11] Undang Undang Republik Indonesia No 24 Tahun 2007 tentang Penanggulangan Bencana Jakarta p. 50.

[12] BNPB 2018 Sejumlah bencana longsor dan banjir terjang beberapa wilayah di Indonesia [Available from: https://bnpb.go.id/berita/sejumlah-bencana-longsor-dan-banjir-terjang-beberapa-wilayah-di-indonesia.

[13] Priyono K D, Jumadi, Saputra Aand Fikriyah V H 2020 Risk analysis of landslide impacts on settlements in Karanganyar, Central Java, Indonesia International Journal of GEOMATE. 19(73)100-7.

[14] Solopos 2021 Tebing setinggi 35 meter di Beruk, Karanganyar longsor timbun jalan, begini penampakannya.

[15] Solopos 2021 Longsor terjadi di 41 lokasi di Karanganyar, paling parah di Beruk Jatiyoso.

[16] Cahyono S A 2008 Pengetahuan local untuk mitigasi bencana longsor: pelajaran dari bencana tanah longsor di Banjarnegara symposium nasional Mahasiswa Pascasarjana tahun 2008: 100 tahun kebangkitan nasional dalam berbagai perspektif 16-17 Mei 2008 (Yogyakarta: UGM).

[17] Nawawi H 2003 Manajemen Sumber Daya Manusia Untuk Bisnis yang Kompetitif (Yogyakarta: Gadjah Mada University Press).

[18] Lithourgidis A, Dordas, CDamalas C A, and Vlachostergios D N. Annual Intercrops: an alternative pathway for sustainable agriculture. Review Article. Australian Journal of Crop Science 2011;5(4):396-410.

[19] Pokhrel K P, Khatiwada S P, Paudya; N P, Dhakal K R, Chidi C L, Timilsena, N P, and Mahat D K, 2021 Innovative practices for the promotion of local/indigenous knowledge for disaster risk reduction management in Sudur Paschim Province, Nepal. . Journal of engineering and Applied Sciences Technology. 3(2)1-7.

[20] Astuti N W, Wendhiana I K, and Wahyono U 2021 Impact of direct disaster experience on teachers'knowledge, attitudes and perceptions of disaster risk reduction curriculum implementation in Central Sulawesi, Indonesia. International Journal of Disaster Risk Reduction. 53.

[21] Raymond C, Fazey I, Reed M S, Stringer L.C., Robinson, G.M & Evely, A.C. Integrating local and scientific knowledge for environmental management. J Environ Manag. 2010;91(2010):1766-77.

[22] Hiwasaki L, ; Luna, E.; Syamisdik.; Shaw, R. Process for integrating local and indigenous knowledge with science for hydro-meteorological disaster risk reduction and climate change adaptation in coastal and small island communities. International Journal of Disaster Risk Reduction 2014;10:15–27.

[23] Okada T, Howitt, R., Haynes, K., Bird, D & McNeney, J. Recovering local sociality: learnings from post-disaster community-scale recoveries. Int J Disaster Risk Reduct. 2018;31(2018):1030–42.

[24] Thomas DSGT, C. Good or bad rangeland? Hybrid knowledge, science, and local understandings of vegetation dynamics in the Kalahari. Land Degrad Dev. 2004;15(2004):215-31.

[25] Kelman I, , Mercer, J & Gaillard, J. Indigenous knowledge and disaster risk reduction. Geography. 2012;97(1):12-21.
[26] Escobar A. Culture sits in places: reflections on globalism and subaltern strategies of localisation. Polar Geogr. 2001;20(2001):139–74.
[27] Nygren A. Local knowledge in the environment–development discourse from dichotomies to situated knowledges. Critiq Anthropol. 1999;19(1999):267-88.
[28] Bohensky ELM, Y. Indigenous knowledge, Science, and Resilience: what have we learned from a decade of international literature on “integration”? . Ecol Soc. 2011;16(2011).
[29] Nguyen TPL, Seddaiu, G & Roggero, P.P. Hybrid knowledge for understanding complex agri-environmental issues: nitrate pollution in Italy. Int J Agric Sustain. 2014;12(2014):164–82.
[30] Sumantri SH, Kurniadi, A., Marnani, C., Sutawidjaya, A.H. Improvement of community capacity in facing the landslide in Sukajaya subdistrict of Bogor Regency. . Technium Social Science Journal. 2021;18(2021):317-32.
[31] Sultana NT, S. . Landslide mitigation strategies in southeast Bangladesh: lessons learned from the institutional responses. International Journal of Disaster Risk Reduction. 2021;62(102402).
[32] Son HN, ; Kingsbury, A ; Hoa, H.T. Indigenous knowledge and the enhancement of community resilience to climate change in the Northern Mountainous Region of Vietnam. Agroecology and Sustainable Food Systems. 2021;45(4):499-522.
[33] Kurnio H, ; Fekete, A.;, Naz, F.;, Norf, C ; Jupner, R. Resilience learning and indigenous knowledge of earthquake risk in Indonesia. International Journal of Disaster Risk Reduction. 2021;62(102423).
[34] Wardyaningrum D. Perubahan Komunikasi Masyarakat Dalam Inovasi Mitigasi Bencana di Wilayah Rawan Bencana Gunung Merapi. Jurnal ASPIKOM. 2014;2(3).
[35] Kusumasari B, Alam, Q & Siddiqui, K. Resource Capability For Local Government in Managing Disaster. Disaster Prevention and Management. 2010;19(4):438-51.
[36] Suryandari. N & Wijayani QN. Environmental Communication, Local Wisdom, and Mitigation of Sampang Flood. Jurnal Komunikator. 2021;13(1).
[37] Kusumastuti RD, ; Ariansyah, A.;, Nurmala, N.,; Wibowo, S.S. Knowledge management and natural disaster preparedness: a systematic literature review and a case study of east Lombok, Indonesia. International Journal of Disaster Risk Reduction. 2021;58(102223).
[38] Suwarsito S. The preserve of local wisdom to mitigate the landslide disaster in Gununglurah Village, Cilongok, Banyumas, Central Java. Advanced Science Letters. 2018;24(1):147-9.
[39] Efendi RS. Pengendalian Erosi Tanah Dalam Rangka Pelestarian Lingkungan Hidup. Jakarta: Bumi aksara; 2000.
[40] Wijayanto HWW, A; Anantayu, S. Perilaku dalam Pengelolaan Lahan Pertanian di Kawasan Konservasi Daerah Aliran Sungai (DAS) Hulu Kabupaten Karanganyar. Agrihumanis. 2021;2(1).
[41] Kurniati E, Suharto, B., & Afrilia, T. Desain jaringan irigasi curah (sprinkler irrigation) pada tanaman anggrek. Jurnal Teknologi Pertanian. 2007;8(1):35-45.
[42] Marimin. Teknik dan Aplikasi Pengambilan Keputusan Kriteria Majemuk. . Jakarta: PT.Gramedia Widiasarana Indonesia; 2004.