

The Factors Affecting Sustainable Sand Mining Practices in Zanzibar: A Case of Kaskazini B District, Unguja Zanzibar

Patima Abubakar Abdisalami

Master of Science in Natural Resources Management, Department of Geography and Environmental Studies, The University of Dodoma, Tanzania

Email:ptmabdi5@gmail.com

Abstract: *The study examines factors affecting sustainable sand mining practices in Kaskazini B District, Unguja, Zanzibar. The cross-sectional design was adopted with a quantitative approach to collect data from 320 household respondents. The primary data was collected from three shehias (Fujoni, Pangatupu, and Donge mbiji) in Kaskazini B District. Data was collected through household surveys by using a questionnaire tool. Descriptive statistics were used to analyze quantitative data. The results show more than half of the participants, 55.1% agreed that delayed rehabilitation of the mined sites is a primary factor affecting the proper implementation of sustainable sand mining. Furthermore, the study discovered that 53.2% of the respondents reported over-extraction of sand. In addition, 18.3% reported population growth, and 13.9% of the respondents reported the expansion of urbanization as among the factors contributing to improper implementation of sustainable sand mining in the study area. However, the study indicates ways of improving SSMP through effective monitoring, enforcement and using other building materials to reduce the rate of land destruction. The study concludes that early rehabilitation is required to protect the environment from deterioration. In light of this, the study recommends using other alternative building materials to reduce the use of natural sand.*

Keywords: Sand, mining, Practices, Zanzibar

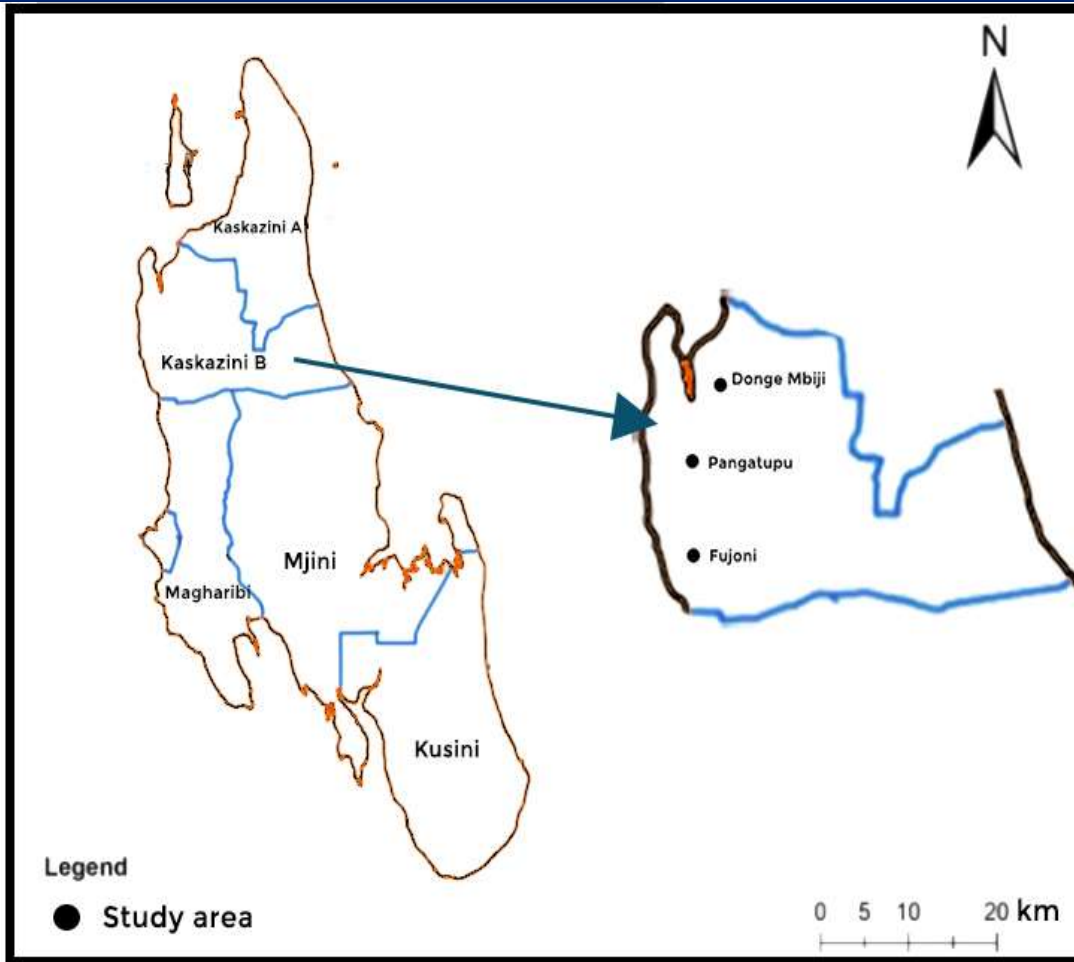
Introduction

Worldwide, sustainable sand mining has become essential for solving environmental problems caused by sand mining (Filho *et al.*, 2021). The UNEP (2019) states that strategic planning is required worldwide to sustain environmental conditions. According to Gavriletea (2017), sustainable sand mining has been practised as the primary means to sustain sand resources to meet the construction industry's needs because sand has been used as the main component in various construction materials. It is the most consumed natural resource after water across the world, with about 50 billion tons of sand extracted each year (UNEP, 2014; UNEP, 2019). It is estimated that about 30 billion tons of extracted sand are used for construction purposes across the world (UNEP, 2014). Sustainable sand mining practices are required in developed and developing countries to solve environmental problems and improve people's income (Peduzzi, 2014). Due to the increasing severity of coastline and mangrove erosion in Zanzibar, the Kaskazini B District has only permitted sand mining activities in Unguja (Masalu, 2002; Ladlow, 2015). This is done to practise sustainable sand mining in an approved area efficiently, enhance its sustainability, and provide benefits for the current and future generations.

Methodology

Study Area

Kaskazini B is one of the two districts of the Kaskazini Unguja Region. It is located about 11 miles from Mjini magharibi region. It is located at latitude 5°72' South and longitude 39°3' East. The temperature ranges between 24°C and 31°C. Long rains start from March to June, and short rains occur in November. The average rainfall ranges between 1,319mm and 1,942mm. The average rainfall is about 1,630.5mm annually (OCGS, 2019). Three shehias in Kaskazini B District, Unguja, and Zanzibar were studied, including Donge mbiji, Pangatupu, and Fujoni (Figure 3.1). These shehias were purposefully selected due to the presence of extraction of sand. According to Ladlow (2015), Kaskazini B District is the only accepted legal area for sand mining in Unguja Island.



Legend

● Study areas

Figure 1: Location of the Study Shehia

Sources: Adopted from www.google.com

Research Design

The study employed a cross-sectional research design because the method enabled the researcher to collect data on sand mining at once and within a short period (Levin, 2006). Also, it is typically conducted faster and is inexpensive (Seita, 2016).

Research Approach

The quantitative method is used specifically for collecting data from a household survey by using questionnaires as a tool used in this method, which is in numerical value. Therefore, this study allowed the researcher to collect numerical data within a short period and also helped the researcher to collect data with minimum cost.

Data Collection

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Data Analysis

The quantitative data, which had numerical values, were gathered through household surveys using questionnaires and analysed using descriptive statistics. These were coded and entered into a Statistical Package for Social Sciences (SPSS V.20) for analysis.

Results and Discussion

Kind of factors affecting sustainable sand mining practices

The results in Figure 2 show factors affecting sustainable sand mining practices in the Kaskazini B district. The results show that 55.1%, 30.3%, and 28% of the respondents in Fujoni, Pangatupu, and Donge mbiji shehia, respectively, reported that delayed

rehabilitation of the mined sites as one of the main factors affect SSMP as shown on (Plate 1) below.



Plate 1: Delaying Rehabilitation on the Mined Sites Influence Rate of Environmental Effect

Source: Field data, 2021

This implies that respondents agreed that delayed rehabilitation also affects sustainable sand mining practices in Kaskazini B District, because it leads to open pits that are not environmentally friendly. The result is in line with Abraham et al. (2021), who observed the presence of several open pits not rehabilitated in Akwalbom State in Nigeria. Similarly, Mark (2021) pointed out that irregular time for rehabilitation of mined sites is caused by inadequate monitoring after mining which reduces the efficiency of SSMP because it reduces close observation of post-mined sites. Furthermore, Bhoopathy & Subramanian (2022) reported that lack of rehabilitation of the destructed mined area, resulting in a lack of enforcement of policy and regulations, leads to a lack of regular follow-up of the mined area after mining to ensure that the mined sites are well rehabilitated or not. Thus, effective rehabilitation of mined pits improves the environmental condition and provides positive outcomes.

Furthermore, the results in Figure 2 show that 31.4%, 53.2% and 39.8% of the respondents in Fujoni, Pangatupu and Donge mbiji shehia, respectively, reported over-extraction of sand as among the factor affecting SSMP. This implies that respondents agreed that extraction affects SSMP in the Kaskazini B district. This is due to the rate of sand extracted frequently increasing. Peduzzi (2014) and Stephen (2019) argued that sand extracted has almost doubled, affecting sustainable sand mining practices because a large quantity of sand removed than its renewable rate. Likewise, Ashraf et al. (2011) revealed that over-extraction of sand damages various infrastructures and public assets. At the same time, Bhoopathy & Subramanian (2022) confirmed that over-extraction increases environmental hazards and a decline in biodiversity. Therefore, the government should ensure enough training for the community and sand miners concerning the environmental effects caused by the over-extraction of sand.

Moreover, the results show that in Fujoni shehia, 8.5% of the respondents reported population growth as a factor affecting SSMP, 11% of respondents in Pangatupu shehia, and 18.3% of the respondents in Donge mbiji shehia reported on population growth as among the factors affecting SSMP.

This result implies that human population growth affects sustainable sand mining practices in the Kaskazini B district because it leads to increasing demand for sand to meet construction purposes; for instance, increasing population also lead to the increasing number of houses and public infrastructures such as schools and hospital. According to the UN(2019), the world population increased frequently and is estimated from 7.7 billion in 2019 to 9.7 billion in 2050. Also, Tanzania National Census, Zanzibar, population growth from 981,754 in 2002 and 1,303,569 in 2012 (OCGS, 2016;URT, 2014).

Gavriletea (2017) pointed out that human population growth is the main factor affecting SSMP worldwide. Likewise, Bhoopathy & Subramanian (2022) revealed that sand consumption increases by increasing the human population. At the same time, Adesina & Adunola (2017) believed that the increase in human population influence the increasing number of labours who can provide positive changes in a particular area. Thus, improving SSMP in the community should go hand in hand with sand mining instructions planned by the government. Also, there is a need to find means for helping the community meet the construction industry and people's requirements without negatively affecting SSMP.

Additionally, the results show that 5%, 5.5% and 13.9% of the respondents in Fujoni, Pangatupu and Donge mbiji shehia, respectively, reported the expansion of urbanization as among the factors affecting SSMP. This implies that respondents agreed that improving urbanization and an increasing number of houses affect the implementation of SSMP because it increases the demand for sand to meet the requirements of the construction industry, such as the construction of houses and government and private projects. Furthermore, Gavriletea (2017); Atejioye & Odeyemi (2018), and Aliu et al. (2021) narrated that the improvement of urbanization influences the demanding sand mined legally and illegal mining due to the establishment of modern houses and modern infrastructures such as roads, offices, malls and housing. Therefore, for that reason, urbanization includes a factor affecting SSMP through influencing sand extraction, both legally and illegal mining.

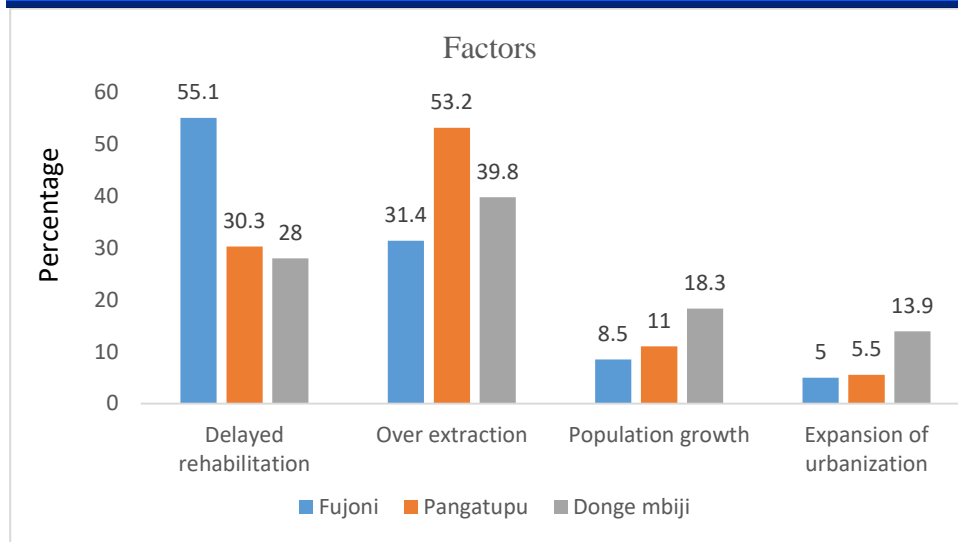


Figure 2: Kind of Factors Affecting Sustainable Sand Mining Practices in the Study Area
 Source: Field data, 2021

Suggestions for Improving Sustainable Sand Mining Practices

Respondents listed suggestions for improving sustainable sand mining practices in the study area based on their experience. The results in Figure 3 show that 53.4% of the respondents suggested effective monitoring as the primary means for improving sustainable sand mining practices in their shehia.

This implies that respondents agreed that SSMP could be achieved through effective monitoring of the mining sites because it influences close observation in all mining stages and after mining. This can enhance the proper implementation of sustainable sand mining procedures. The findings correlate with Mark (2021) pointed out that ineffective monitoring affects sustainable sand mining practice achievement due to irregular follow-up and attendance at the mining area. It is also revealed by other scholars such as Torres et al. (2017) and Abraham et al. (2021) that the lack of effective monitoring of mined sites after the mining of sand is among the main factors that affect sustainable sand mining practices. Therefore, the government, through responsible institutions, makes sure the officers attend to the mining area before and after mining to ensure everything is done as instructed in sand mining regulations. Furthermore, the results show that 33.4% of the respondents suggested finding other alternative building materials. This implies that respondents believe the uses of alternative building materials help sustainable sand mining practices because the uses of different building materials reduce over extraction and utilisation of sand. Various researchers worldwide emphasise a search for other building materials to reduce dependency on natural sand (Stephen, 2019).

Sankh *et al.* (2014) and Dubal (2018) found that using alternative building materials such as crushed stone is a reasonable alternative and provides good results for construction purposes as used in block making. Likewise, Stephen (2019) noted that the use of alternative building materials provides freedom to people in selecting materials affordable to their economic level and technology. However, the results contradict the findings by Heveran *et al.* (2020) and Qiu *et al.* (2021). They are against this and suggest avoiding using mined resources instead of depending on the new technology of using living building materials such as bacteria which is environmentally sound. For that reason, the government must allow their experts to do several research on locally available materials to reduce dependency on the sand.

Moreover, the results show that 13.1% of the respondents suggested effective enforcement of sand mining regulations. This implies that respondents agreed that effective enforcement of sand mining regulations in the Kaskazini B district could enhance sustainable sand mining practices; because it helps successful compliance with sand mining regulations and understanding their responsibilities. Study findings correlate with Arwa (2013) and Katisya-njoroge (2021) regarding this issue. They argued that effective enforcement of sand mining regulations could help reduce adverse effects of sand mining, such as minimising the presence of open quarries in mining areas and enhancing environmental health and achievement of sustainable sand mining. Similarly, Abraham et al. (2021) confirmed that strict enforcement and implementation of sustainable sand mining regulations is essential to enhance the benefit of people and the environment. Therefore, strict enforcement of sand mining regulations enables proper implementation of planned sand mining rules and regulations for government officers and local people.

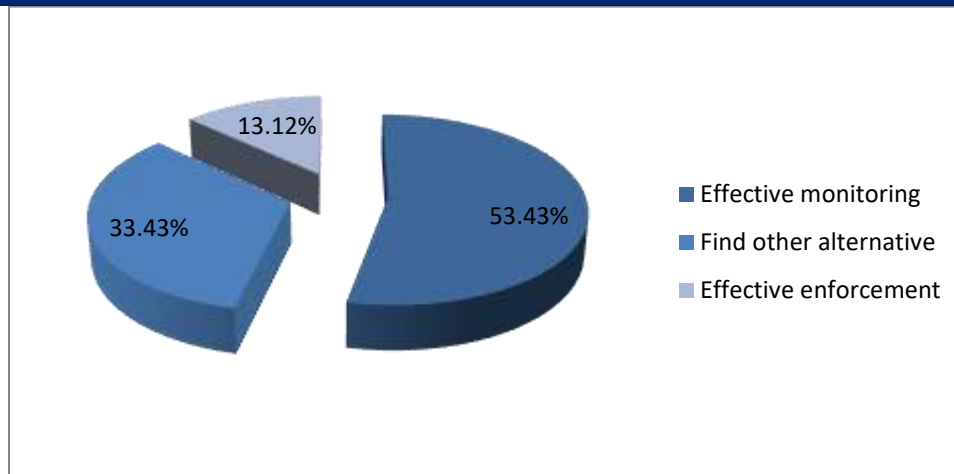


Figure 3: Suggestions for Improving Sustainable Sand Mining Practices in the Study Area

Source: Field data, 2021

Conclusion

Based on the results, it was revealed that respondents identified some factors affecting SSMP in the study area, based on these factors identified by the respondents include increasing human population and improvement of urbanization influences increasing of extraction of sand to meet their requirements for building and construction of public and private projects such as schools, malls, road. Also, the result showed that previously, SSMP was affected mainly by over-extraction of sand and delayed rehabilitation, resulting in the presence of open mined pits, which are not environmentally friendly. However, respondents suggested ways for improving sustainable sand mining practices in their shehia; these include adequate monitoring of mining sites in all stages before and after mining. Also, it suggested that the government should find alternative building materials to reduce sand extraction and consumption and effectively enforce sand mining rules and regulations.

Recommendations

The study's findings support the following recommendations:

The study findings revealed a need to sustain sand resources in the study area by frequently rehabilitating mined sites and using other alternative building materials to reduce sand consumption. Therefore, this study suggests to the Ministry of Land under the ZURA department to conduct a study to examine the effect and effectiveness of locally available materials before formalising their uses.

Area for Further Research

Although there is a presence of sustainable sand mining practices, further research is proposed to be conducted on the effectiveness of different alternative building materials to avoid sand extraction in Kaskazini B District in order to allow the plots that are used for sand mining to be used for agricultural activities which can help to reduce food insecurity and increasing income for people in Kaskazini B District.

LIST OF ABBREVIATIONS

OCGS	Office of the Chief Government Statistician
UN	United Nations
UNEP	United Nations Environmental Program
URT	United Republic of Tanzania
SSMP	Sustainable Sand Mining Practices
SPSS	Statistical Package for Social Sciences
ZURA	Zanzibar Utilities Regulatory Authority

ACKNOWLEDGEMENT

The author thanks the University of Dodoma and the Second Vice President's Office for giving me the chance to do this research. Moreover I thank my supervisor for her contribution to the preparation of the manuscript

REFERENCES

- [1] Abraham, C., Essien, K., Umoh, E., Umoh, E., Ehremem, L., Akpan, V., & William, N. (2021). Towards effective monitoring of sand mining sites and post management techniques in sand dredged environment of Akwa Ibom State, Nigeria. *Global Journal of Ecology*, 6(1), 92–99. <https://doi.org/https://dx.doi.org/10.17352/gje>
- [2] Adesina, T. K., & Adunola, O. A. (2017). Perceived effects of sand dredging on livelihood diversification of artisanal fisher folks in Lagos State, Nigeria. *Agricultura Tropica et Subtropica*, 50(2), 71–79. <https://doi.org/10.1515/ats-2017-0008>

- [3] Aliu, I., Akoteyon, I., & Soladoye, O. (2021). Sustaining urbanization while undermining sustainability: the socio-environmental characterization of coastal sand mining in Lagos Nigeria. *GeoJournal*. <https://doi.org/10.1007/s10708-021-10563-7>
- [4] Arwa, G. (2013). Sustainable governance for artisanal sand mining - Case of Kangonde location , Masinga District. In *Thesis*. University of Nairobi.
- [5] Ashraf, M. A., Maah, M. J., Yusoff, I., Wajid, A., & Mahmood, K. (2011). Sand mining effects, causes and concerns: A case study from Bestari Jaya, Selangor, Peninsular Malaysia. *Scientific Research and Essays*, 6(6), 1216–1231. <https://doi.org/10.5897/SRE10.690>
- [6] Atejiyoe, A. A., & Odeyemi, C. A. (2018). Analysing impact of sand mining in Ekiti State, Nigeria using GIS for sustainable development. *World Journal of Research and Review*, 6(2), 26–31. www.wjrr.org
- [7] Bhoopathy, V., & Subramanian, S. S. (2022). The way forward to sustain environmental quality through sustainable sand mining and the use of manufactured sand as an alternative to natural sand. *Environmental Science and Pollution Research*, 29, 30793–30801. <https://doi.org/10.1007/s11356-022-19633-w>
- [8] Dubal, A. (2018). The utilization of crushed stone dust as replacement of sand in cement concrete. *Journal of Engineering Research and Application*, 8(9), 11–14. <https://doi.org/10.9790/9622-0809031114>
- [9] Filho, W. L., Hunt, J., Lingos, A., Platje, J., Vieira, L. W., Will, M., & Gavriletea, M. D. (2021). The Unsustainable use of sand : Reporting on a global problem. *Sustainability*, 13(3356), 1–16. <https://doi.org/10.3390/su13063356>
- [10] Gavriletea, M. (2017). Environmental impacts of sand exploitation. Analysis of sand market. *Sustainability*, 9(7), 1118. <https://doi.org/10.3390/su9071118>
- [11] Heveran, C., Williams, Sarah, L., Qiu, J., Cameron, J. C., Wil V, S., Artier, J., Hubler, M. H., & Cook, S. M. (2020). Biomineralization and successive regeneration of engineered living building materials. *Matter*, 2(2), 481–494. <https://doi.org/https://doi.org/10.1016/j.matt.2019.11.016>
- [12] Katsiya-njoroge, C. (2021). Kenya’s Sand harvesting laws and the sustainable development licence to operate: in quicksand? *Journal of Cmsd*, 6(3), 167–186.
- [13] Ladlow, C. (2015). *An assessment of the impact of sand mining: Unguja , Zanzibar*. 1–39. Retrieved from https://digitalcollections.sit.edu/isp_collection/2048
- [14] Levin, K. A. (2006). Study design III: Cross-sectional studies. *Evidence-Based Dentistry*, 7(1), 24–25. <https://doi.org/10.1038/sj.ebd.6400375>
- [15] Masalu, D. C. P. (2002). Coastal erosion and its social and environmental aspects in Tanzania: A case study in illegal sand mining. *Coastal Management*, 30(4), 347–359. <https://doi.org/10.1080/089207502900255>
- [16] Mark, M. E. (2021). *The governance of global sand mining, Thesis*. University of Waterloo, Canada.
- [17] Peduzzi, P. (2014). Sand, rarer than one thinks. Article reproduced from United Nations Environment Programme (UNEP) Global Environmental Alert Service (GEAS). *Environmental Development*, 11, 208–218. Retrieved from <http://archive-ouverte.unige.ch/unige:75919>
- [18] Qiu, J., Cook, S., Srubar, W. V., Hubler, M. H., Artier, J., & Cameron, J. C. (2021). Engineering living building materials (LBMs) for enhanced bacterial viability and mechanical properties. *ISCIENCE*, 1–19. <https://doi.org/10.1016/j.isci.2021.102083>
- [19] Sankh, A. C., Biradar, P. M., Naghathan, S. J., & Ishwargol, M. B. (2014). Recent trends in replacement of natural sand with different alternatives. *IOSR Journal of Mechanical and Civil Engineering*, 59–66. <https://www.researchgate.net/publication/323239519>
- [20] Seita, M. S. (2016). Methodology series module 3 cross-sectional studies. *Indian J Dermatol*, 61(3), 261–264. <https://doi.org/10.4103/0019-5154-182410>
- [21] Stephen, C. (2019). Shifting sand: Why we ’ re running out of aggregate. *Construction Research and Innovation*, 10(3), 69–71. <https://doi.org/10.1080/20450249.2019.1656448>
- [22] Torres, A., Brandt, J., Lear, K., & Liu, J. (2017). A looming tragedy of the sand commons. *Science*, 357(6355), 970–971. <https://doi.org/10.1126/science.aao0503>
- [23] UN. (2019). *World population prospects 2019: Highlights* (26 ed). United Nations.
- [24] UNEP. (2014). *Sand , rarer than one thinks: UNEP Global Environmental Alert Service (GEAS)*. 1–15. Retrieved from www.unep.org/geas
- [25] UNEP. (2019). *Sand and sustainability: Finding new solutions for environmental governance of global sand resources*. Geneva, Switzerland.
- [26] URT. (2014). *Basic demographic and socio-economic profile, Tanzania Zanzibar. National Bureau of Statistics Ministry of Finance Dar es Salaam and Office of Chief Government Statistician Ministry of State, President Office, State House and Good Governance Zanzibar*.
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