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This is the Published version of the following publication

Oyinna, Benneth, Okedu, Kenneth E, Diemuodeke, Ogheneruona, David, Lois E, Negedu, Isaac O, Osemudiamen, Elijah A, Colak, Ilhami and Kalam, Akhtar (2023) Assessing small hydropower sites in Nigeria for sustainable development using ArcGIS. Energy Reports, 10. pp. 2889-2898. ISSN 2352-4847

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Energy Reports 10 (2023) 2889–2898

Contents lists available at ScienceDirect

Energy Reports

journal homepage: www.elsevier.com/locate/egyr

Research paper

Assessing small hydropower sites in Nigeria for sustainable development using ArcGIS

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ARTICLE INFO

Keywords:
Small hydropower
Flow rate
Power potential
Renewable energy
ArcGIS

ABSTRACT

This paper focuses on the prospects of small hydropower plants (SHP) in Nigeria and utilizes ArcGIS software for analyzing the country's hydropower energy potential. The analysis conducted using ArcGIS reveals the significant SHP potential in various states across Nigeria. By overlaying water areas and waterline data on maps, potential sites for SHP are identified, particularly in states such as Borno, Niger, Edo, Anambra, and Jigawa. Further analysis was done using data for water lines in Nigeria converted into shaped files for the six geopolitical zones of Nigeria, with the various states and local government areas, to provide expanded views for different possible schemes for SHP. Data set were built up for the different geopolitical zones and statistical analyses were done for SHP potentials. Interpolations were performed using Inverse Distance Weighting (IDW) tool on ArcGIS to show areas ideally suitable to site dam schemes for hydropower production and other schemes that require less water storage for small hydropower production. The strengths of each state in the various zones with regard to water inlands and lands subject to inundation were also identified. Some major challenges and opportunities in using ArcGIS in assessing small hydropower schemes in Nigeria, were also highlighted.

1. Introduction

Over 160 nations across the world currently employ hydropower technology to generate electricity (Okedu and Al Siyabi, 2021). As a result, modern installations of hydropower across the world now account for more over 16% of total energy production (IEA, 2012, 2008), making hydropower one of the most effective renewable energy sources for generating electricity (Working Group III, 2017; Gagnon, 2008). The technology of hydropower has flexible operation and could be very useful for energy mix especially in developing countries, since it possesses a reservoir scheme that could be helpful in improving the quick response to fluctuations in power demand in power grids (Adhikari and Wood, 2018).

Nearly 60 years after independence, Nigeria's energy sector is still in a state of limbo, and the main causes are the country's persistently corrupt authorities and participants in the power business. In 2050, Nigeria's population is projected to increase to nearly 400 million, making it the third-most populous nation after China and India (UN, 2023). As a result, the nation's energy consumption is anticipated to continue to soar. Nigeria now produces less than 4000 MW of energy, but given the country's potential, it has the opportunity to increase that output through modest hydropower. Nigeria mainly relies on fossil fuels to generate energy due to the country's massive reserves of crude oil and natural gas. Despite having a large crude oil reserve, Nigeria produces less power and only uses 0.03 kW per person. Despite the installed total capacity being estimated at 11,756 MW as early as 1999, this is the current reality (NERC, 2015; PHCN, 2016). Before the discovery of crude oil in Nigeria, hydropower was the only source of electrical power, according to Ohunakin's report from 2010 (Ohunakin and Ojolo, 2010).

The decline in the growth of the hydropower sector was caused by the change in focus toward fossil fuels as a result of Nigeria's massive fossil fuel reserves. Hydropower is an energy source that predates fossil fuels and continues to advance in technology. Many nations throughout the world, including China, Italy, the USA, and others, have continued to pay close attention to small-scale hydro projects since they have the least negative social and environmental effects. China is the world leader in

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https://doi.org/10.1016/j.egyr.2023.09.102
Received 1 July 2023; Received in revised form 18 September 2023; Accepted 18 September 2023
Available online 26 September 2023
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the development of small hydropower and has already built more than 58,000 smaller plants with a combined capacity of more than 13,000 MW (IRENA, 2022; UNCCTCN, 2021). France, Italy, the US, and Sweden are more nations that are actively developing small hydroelectric facilities. Over 1200 small-scale hydroelectric facilities have already been built in each of these nations, and more are planned for each (Igram, 2020; Anon, 0000). There was a rise in the global installed hydropower capacity by 26 GW to 1360 GW in 2021, compared to 1330 GW in 2020 (IRENA, 2022). A total of 4250 TWh clean electricity was generated from hydropower in 2022, with only China contributing 80% of new hydropower capacity installed in 2021 (IHA, 2022). Africa is only contributing about 38 GW of hydropower globally compared to the other regions of the world with substantial amount of hydropower (IRENA, 2022).

Given Nigeria's numerous rivers and dams, which may be economically utilized to raise the percentage contribution of hydroelectricity to the entire energy mix and to provide electricity to rural and isolated regions, there are enormous hydropower potentials accessible there (Okedu et al., 2020; Uhunmwangho et al., 2018; Odje et al., 2018). Reference (Uhunmwangho et al., 2015) carried out an assessment of small hydro power development in Nigeria for sustainable development. The authors argued that the use of small hydropower technology in the country is very low level with the hydropower operation program limited to only three states of the federation. In another study, the hydropower potential assessment of selected sites in Niger state, Nigeria, using geographic information system (GIS) techniques was carried out in (Abdul-Aziz et al., 2018), while the authors in (Yisa et al., 2019), investigated the suitability analysis of sites for hydropower potential in Nigeria, using GIS and multi-criteria decision-making (MCDM) strategies. The spatial and statistical modeling approaches were utilized by the authors in (Ogbonna et al., 2020), for the selection of hydropower sites in Nigeria. In the same vein, Reference (Oluwasanya et al., 2021), also carried out a spatial multi-criteria analysis for identifying suitable sites for small hydropower schemes in Nigeria. Another study that the authors in the literature reported was the mapping of the appropriateness for small hydropower sites in Nigeria using multi-criteria decision analysis (MCDA) and geographic information system (GIS) (Olasoji et al., 2018).

Despite the country's numerous rivers and dams having the capacity to produce hydropower, none of the existing, ongoing, or proposed hydropower projects in Nigeria have been able to fully use that potential. Nigeria's per capita energy consumption would increase if the country took into account its current challenges with power producing capacity and adopted hydropower technology, which has less of an impact on the environment than fossil fuel-powered facilities. In light of this, this paper presents a holistic approach in assessing small hydropower sites in Nigeria using the ArcGIS, which has not been reported, compared to the previous studies to were limited to only certain states in Nigeria using the GIS. The ArcGIS, is a widely recognized and extensively used with more comprehensive set of tools and capabilities, that help in managing, analyzing, and visualizing geospatial data for a variety of applications. The analysis conducted using ArcGIS in this study reveals the significant small hydropower potential in various states across Nigeria. With the help of water areas and waterlines data on maps overlaying, the hydropower potentials were identified in some of the key states in Northern and Southern Nigeria as revealed in this study with potential small hydropower. More so, the data for the water lines in Nigeria was converted into shaped files considering the six geopolitical zones of the country with the various states, local government areas, and larger water bodies. The extraction of data set for the different zones using statistical analyses were carried out. Interpolations were performed using Inverse Distance Weighting (IDW) tool on ArcGIS to show areas ideally suitable to site dam schemes for hydropower production and other schemes that require less water storage for small hydropower production. The results of this study will assist Nigeria's government, stakeholders, and energy policy makers in increasing the proportion of hydroelectricity in the country's overall energy mix. Given the advantages on the economic, social, and environmental fronts, this would further expand access to power in rural and distant places. The verified data used in this study to evaluate the locations in Nigeria's six geopolitical zones with the aid of ArcGIS demonstrates that produced electricity may be boosted significantly if hydropower potentials in various states of the federation of Nigeria are correctly used.

2. Overview of the current status of small hydropower in Nigeria

Micro, mini, and small are terms used to describe and categorize small hydropower plants (SHPs). The assessment of capacity and the definition of SHP are dynamic and based on local economic development. According to (Olayinka et al., 2011), SHP has been in Nigeria since 1923, or 45 years before the country's first major hydropower plant was commissioned in Kainji (Ohunakin and Ojolo, 2010). Additionally, from the middle of the 1940s through the 1980s, the Nigerian Electricity Supply Company (NESCO) was able to use hydropower from the Kurra falls to provide energy to the former Benue-Plateau region.

Nigeria has a significant modest hydropower potential, as Table 1 shows (ECN, 2020). Table 1 makes it clear that the country's energy portfolio could produce 734.2 MW of electricity by utilizing the minor hydro power potentials in just 277 places. The enormous potentials of small hydro power in the 36 states of Nigeria cannot be overstated, especially in light of the fact that the data in Table 1 only includes twelve of the federation's states. As a result, this is one of the goals of the present research.

'Rivers to Power project' was included to the national power plan based on Table 1. According to this plan, Independent Power Projects (IPP) will be created by commissioning and including a map of small hydropower potentials from all around the country. The objective should be to spread out at least 3000 small hydropower projects around the country, each of which would provide at least 10,000 MW to the overall energy supply of the nation. The small hydropower projects' biggest appeal is their potential for usage as off-grid power sources for industrial, Commercial and residential power requirements.

3. Nigeria's hydropower policy

A dynamic renewable energy portfolio standard was created for hydropower projects in Nigeria along the lines of the following in order to make use of the enormous small hydropower potentials (NERC, 2020; Sambo, 2007). The policy basically comprises of; the country must utilize all of its hydroelectric capacity for the production of electricity; the nation will give the development of little and micro hydropower schemes special attention; hydrological resources must be exploited in a way that is ecologically responsible; and active and liberal promotion of private sector and indigenous engagement in hydropower development is required.

Table 1
Small hydro potential in Nigeria's surveyed states.

River basin	State	Capacity (MW)	Unit location
Lower Benue	Benue	69.2	19
Chad	Borno	20.8	28
Upper Benue	Bauchi	42.6	20
Upper Benue	Gongola	162.7	38
Lower Benue	Plateau	110.4	32
Niger	Kaduna	59.2	19
Niger	Niger	117.6	30
Cross River	Rivers	258.1	18
Hadeija- Jamaare	Kano	46.2	28
Niger	Kwara	38.8	12
Sokoto-Rima	Katsina	8.0	11
Sokoto Rima	Sokoto	30.6	22
Total		**734.2**	**277**

The main objectives of the policy are; to raise hydroelectricity's percentage share of the overall energy mix; to employ mini- and micro-hydropower programs to bring electricity to rural and distant locations; to reduce the use of non-renewable resources in the production of power, to ensure that big hydropower development causes the ecology the least amount of harm possible, and to draw investments from the private sector into the hydropower sector. This study tends to provide and analyze some of the policies and objectives listed above in line with the United Nations sustainable development goals.

4. ArcGIS strategy

ArcGIS is a set of Geographic Information System (GIS) software that was created by Environmental Systems Research Institute (ESRI). ArcGIS gives users the ability to organize, analyze, and display geographic data for a number of applications. Thanks to its extensive collection of tools and features.

Users may record, save, alter, analyze, and present geographic data using a wide variety of functions provided by ArcGIS. Data from many sources, such as satellite imaging, aerial photography, Global Positioning System (GPS) data, and other databases, may be seamlessly integrated, thanks to the program. ArcGIS improves the structure of data and effective administration by offering a platform for building and managing geographic datasets (ESRI, 2020).

In the corpus of extant research, the applications of ArcGIS in many sectors have been thoroughly investigated. Numerous studies have demonstrated how well ArcGIS handles diverse geospatial analytic issues and offers insightful information. ArcGIS, for instance, has been used in the field of urban planning to analyze land use patterns and assist decision-making procedures (Wu et al., 2019). Researchers have also employed ArcGIS for transportation planning, assessing accessibility, and optimizing transportation networks (Li et al., 2018).

Through its mapping and visualization tools, ArcGIS excels in data visualization and cartographic output. Users may create aesthetically beautiful maps that effectively communicate geographical patterns and relationships. Thanks to configurable symbology and thematic representations. Users may generate three-dimensional representations of geographical elements and terrains using ArcGIS's 3D visualization features.

5. Methodology

With the help of ArcGIS, the Nigerian map was analyzed considering the six geopolitical zones for small hydropower potentials in Nigeria. The geographical information systems-based analysis provides clearer insights into identifying suitability areas for hydropower generation. In this paper, the spatial analytical tools were used to analyze map shaped files containing data for Nigerian water areas obtained from (UN-FAO, 2019). Fig. 1 shows shape file containing attributes for water areas in Nigeria being overlaid on other shape files containing

Nigeria map (NGA_adm0) and states in Nigeria (NGA_adm1). Data for water areas were overlaid 100% to show available water bodies for small hydro power generation in Nigeria with multiple ring buffers of distances between 200 m to 5 km from the water bodies. These locations accessible by road from the water bodies are identified as potential sites for small hydro power.

This analysis reveals enormous potential for run-off-the river and minor dam projects in states including Borno, Niger, Edo, Anambra, and Jigawa as well as Lagos, Taraba, Adamawa and Yobe. Data for Nigeria's water lines that had been transformed into shaped files for the country's six geopolitical zones, seen in Figs. 2–3, were used for additional analysis. This would aid in providing broader perspectives for various minor hydropower plan options, such as run-off the river plans, ideal for locations remote from major water bodies.

South East (SE) was extracted from the Nigerian map using spatial analysts' tool (clip) and features like water areas and water lines (deep and light blue colors, respectively) were overlaid on the map for SE Nigeria in Fig. 2a, to provide expanded view into rivers and large water bodies for small hydro power generation. A multiple ring buffer for waterlines was simulated using distances of 200m–5000 m showing suitable areas for siting small hydro power projects and reclassed to give the highest priority value to areas within 200 m from the waterlines. However, the limitations of this analysis include not having access to land use land cover data for SE Nigeria to overlay on the map to show the relative positions of built-up areas and other parameters that determine

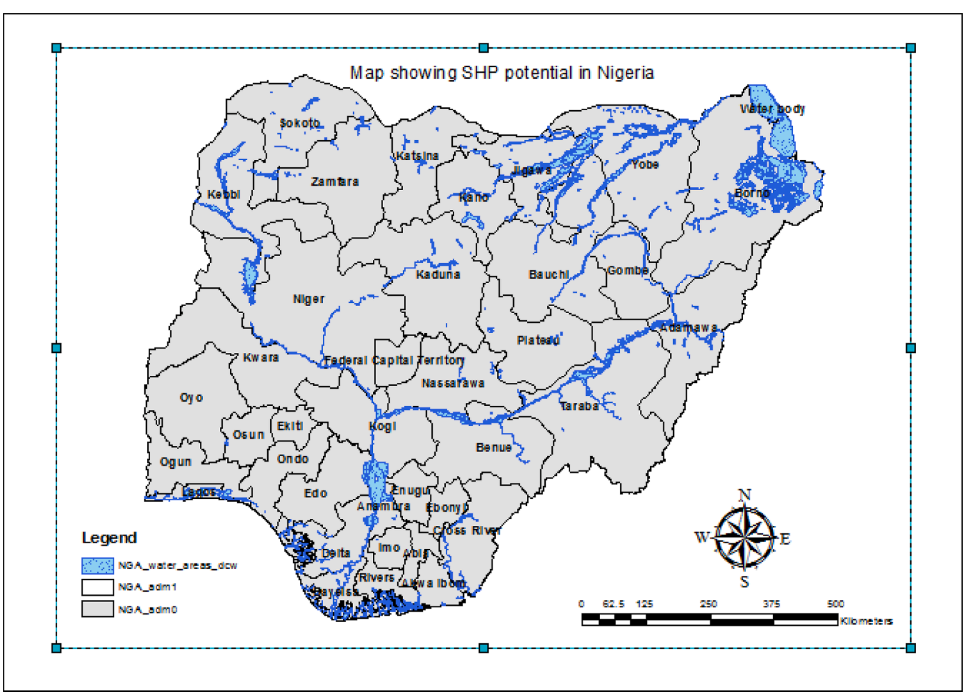

Fig. 1. ArcGIS map showing water areas in Nigeria.

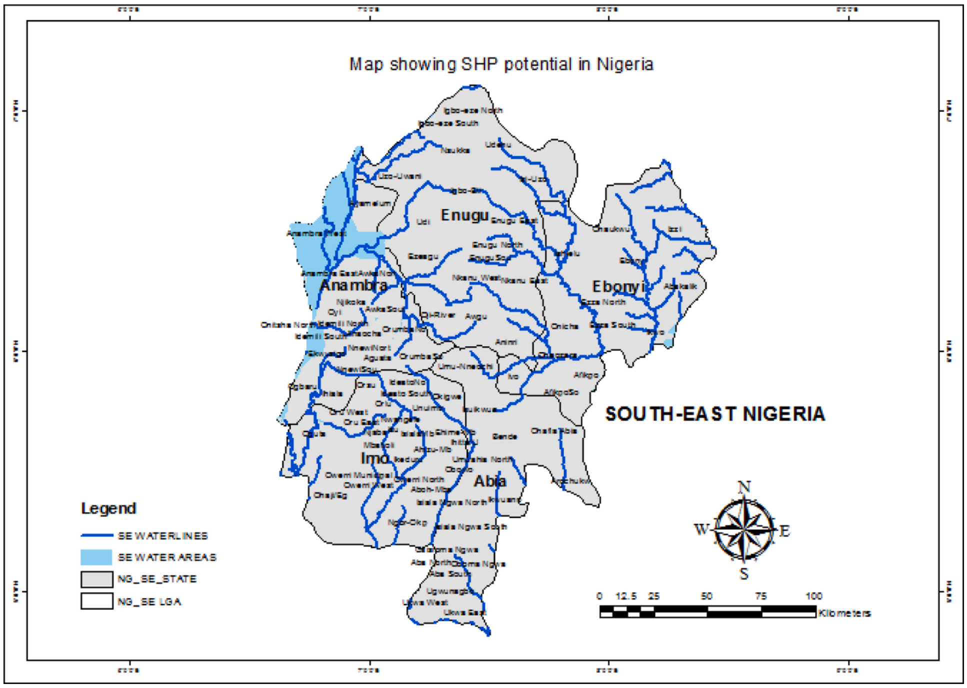

Fig. 2a. Waterlines and water areas in south eastern Nigeria.. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

the overall suitability of the site. The analysis for SE Nigeria showed huge potentials for small hydropower in locations such as Anambra East and West, Idemili south and Ekwusigo local government areas.

Similarly, the map for South-South (SS) Nigeria was extracted from the NGA_adm2 shape file containing data for Nigerian mapped areas in Fig. 2b. Data for water areas and water lines were overlaid on the map using spatial analyst tools to show potential sites for SHP in the SS. The analysis shows Etsako central, Esan north local government areas of Edo state, Oshimil south in Delta and Obubra in Cross River as the most suitable areas for siting SHP. Further considerations can be given to locations like Calabar south, Opobo, Bonny and Warri.

Lagos and Ogun state was shown to have SHP potentials with Lagos Island, Eti-osa and Epe as good locations to site hydro-power stations for the South West map of Nigeria shown in Fig. 3a. Ogun waterside and distances with a buffer of 200–500 m are good locations for siting SHP. From the analysis, these are the only potential sites for the South West, although there are waterlines with sources from River Niger as shown on the map in Fig. 3a. More research may unravel some run-off-the-river schemes in the South-West.

In the North-West, there are hydropower suitability areas in Kebbi,

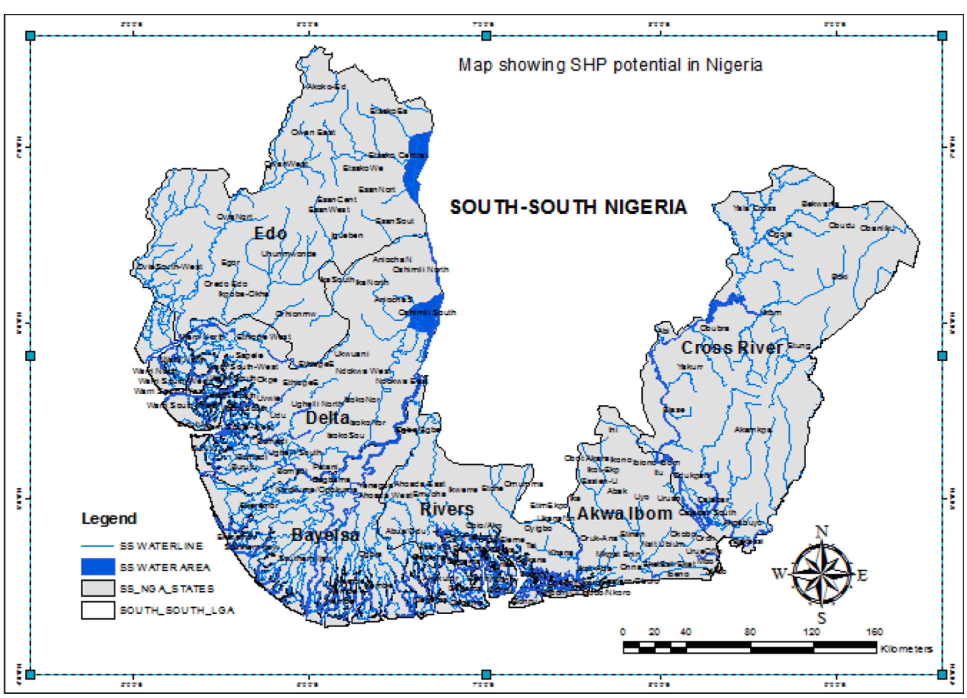

Fig. 2b. Waterlines and water areas in South South Nigeria.

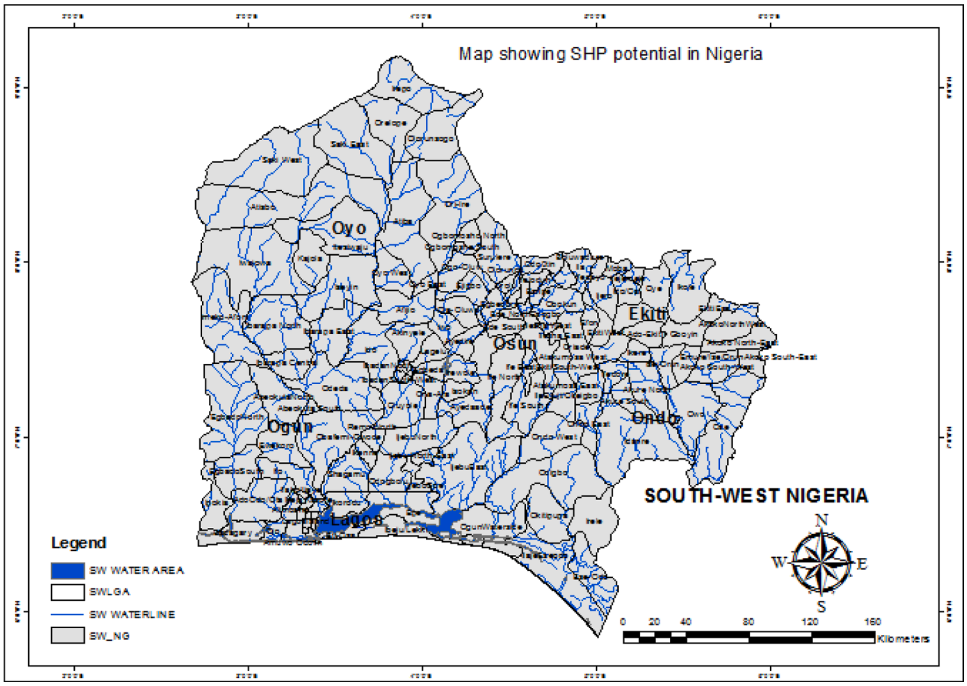

Fig. 3a. Waterlines and water areas in South West Nigeria.

Kano and Jigawa states. From the analysis of Fig. 4a, the following areas has comparatively high-water availability; Ngaski (Kebbi), Tudun Wada (Kano), Hadeja, Guri, Kinkasa and Auyo (Jigawa). There are however other areas with lower availability of water for small head and flow turbines suitable for run-of-the river hydropower scheme.

North Central Nigeria has huge potentials of hydropower generation particularly those locations closest to River Niger, Benue and the confluence town of Lokoja as shown in Fig. 3b. Potential locations include; Ibaji, Idah, Lokoja, Igalamela in Kogi state, Agatu and Guma in Benue State, Borgu and Agwara in Niger state.

ArcGIS analysis for the North Eastern part of Nigeria shown in Fig. 4b, reflects hydropower potential in areas of Borno state close to lake Chad, Gamawa and Zaki in Yobe state, Dukku in Gombe state, Gassol and Ardo-Kola in Taraba state and lower water availability in Numan, Adamawa state.

6. Results and discussions

The data for water areas in Nigeria was analyzed to show the composition of water bodies. It shows various areas with inland waters and lands subject to inundation (water bodies due lands overtaken by water). Interpolations were performed using Inverse Distance Weighting (IDW) tool on ArcGIS to show areas ideally suitable to site dam schemes for hydropower production and other schemes that require less water storage for small hydropower production. The decision for suitability areas using these interpolations will however not be complete if additional insight is not provided about the site elevation (head) and the flow

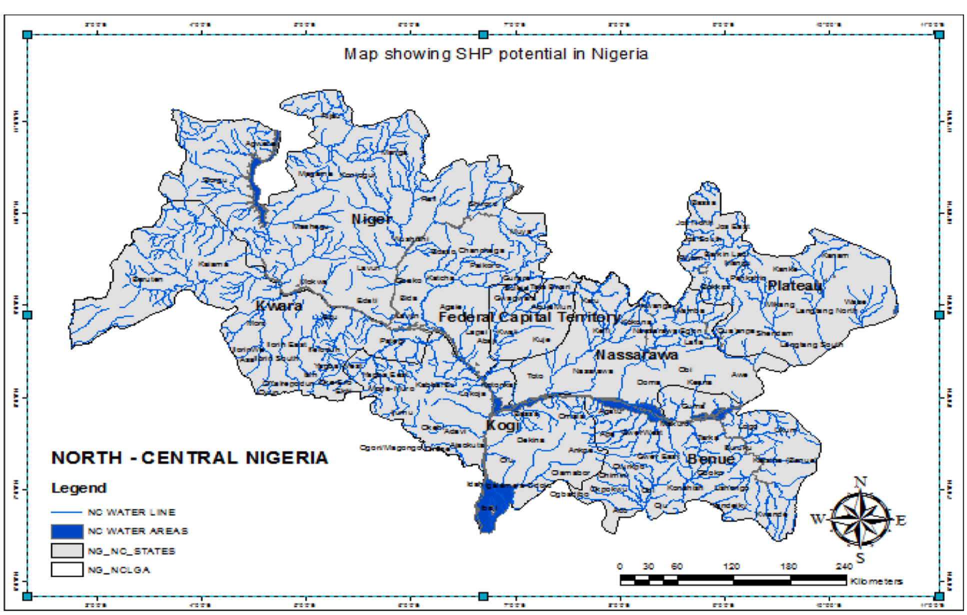

Fig. 3b. Waterlines and water areas in North Central Nigeria.

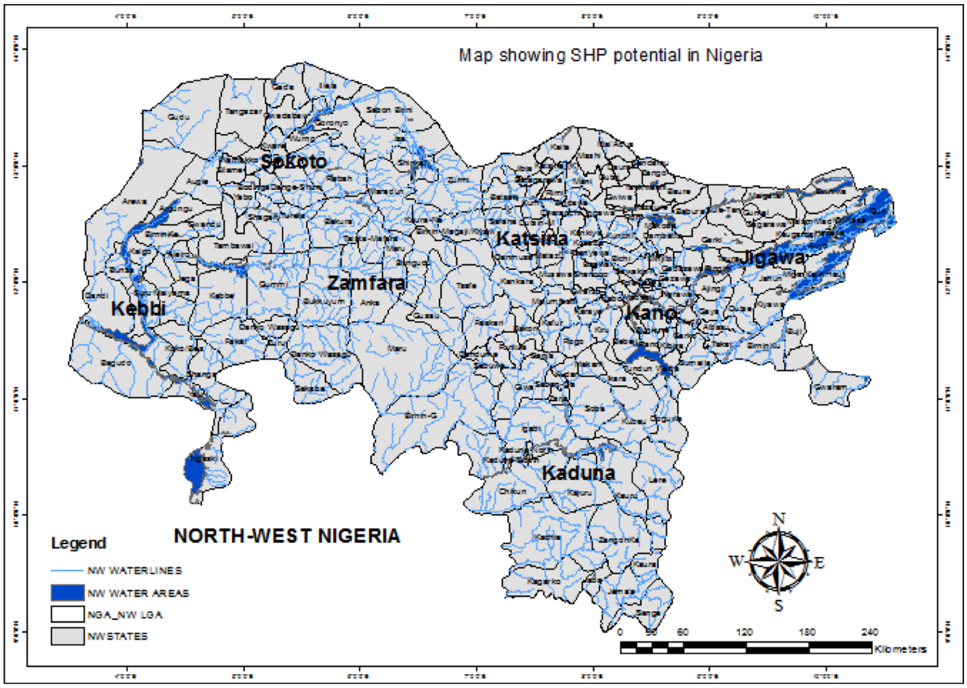

Fig. 4a. Waterlines and water areas in North West Nigeria.

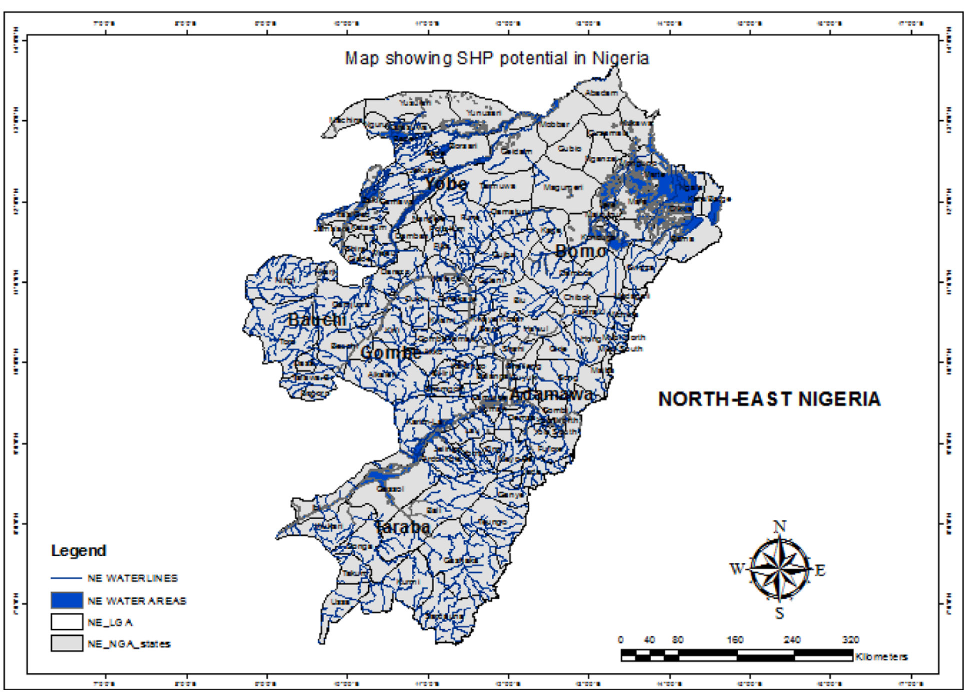

Fig. 4b. Waterlines and water areas in North East Nigeria.

rate of these water bodies, hence determining the capacity of SHP that can be generated from these locations.

Identifying these potential sites therefore provides a step in the right direction for decision making and narrows researchers down to possible sites for further feasibility studies. The results also show the percentage of these inland waters and inundated lands in the six geopolitical zones of Nigeria reflecting the states with the highest and lowest potentials for the various hydropower schemes.

The interpolation in Fig. 5a shows areas in Nigeria with deep inland waters. The column charts show the various quantities of inland waters (blue) and inundated lands (red) as a percentage of the total across the country. These locations are suitable for large hydro power plants. States with highest inland water capacities include, Yobe, Jigawa, Bauchi, Sokoto Adamawa and Niger. Other low-capacity areas include, Delta, Rivers, Cross River and the areas highlighted in light blue colors which may be suitable for small hydro power scheme.

In Fig. 5b, the areas highlighted in deep red show locations where available water comes from overflown water bodies and lands taken over by water. It shows Borno Kebbi, Bauchi, Yobe, Taraba, Kogi etc, are areas with shallow waters from floods and such water overflows from

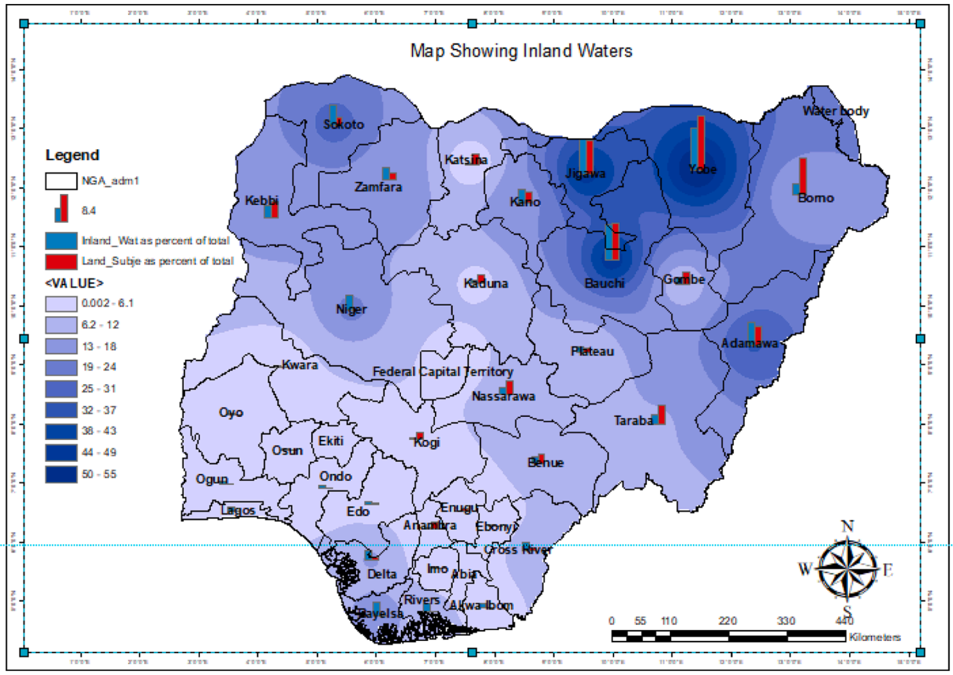

Fig. 5a. Map of Nigeria showing inland waters.. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

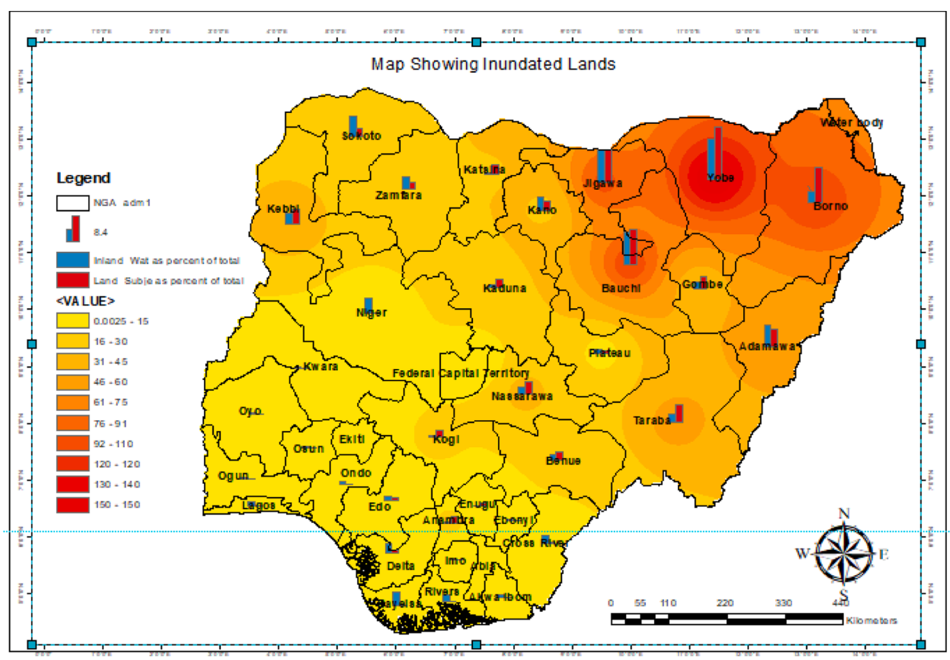

Fig. 5b. Map of Nigeria showing lands subject to inundation.

deep waters, seas and oceans.

Anambra state is shown to be the highest area in Fig. 5c, with water due to inundation and three inland water locations, while Abia state does not have any water area suitable for SHP. It provides insights as to what SHP policy directions should for the South East and how the Anambra -Imo River basin needs to be empowered to conduct further studies to strengthen already existing SHP projects conceived, as stated earlier in this paper with Oguta Lake being the only inland water source for Imo state.

Bayelsa, Delta, Cross River and Rivers states have greater percentage of inland waters that could be explored for dam schemes as shown in Fig. 6a. These sites apart from SHP also provides the best transportation routes for inland ports construction. Delta state as observed has the highest areas in the South South taken over by water.

The South West has more inland waters with major sources from Lekki, Lagos and Ologe Lagoons as shown in Fig. 6b. There are however no lands subject to inundation. These locations can be explored for further studies for SHP but they are obviously suitable areas for sea ports as they are few nautical miles away from the Atlantic Ocean.

In Fig. 7a Yobe state has the highest potential for hydropower in the North East with 58 inland water locations and 151 inundated land sites. These sites could be utilized for irrigation and run off the river schemes

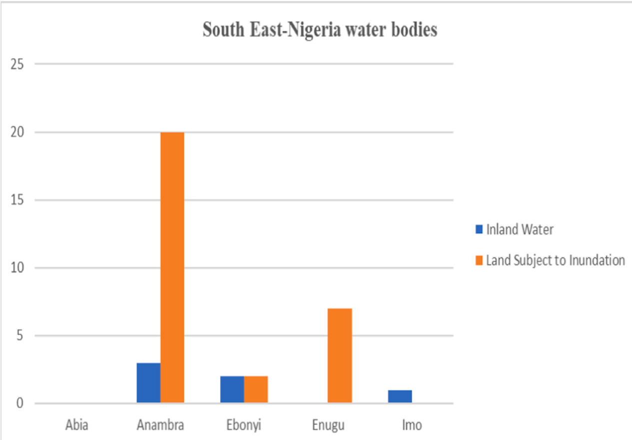

Fig. 5c. Types and capacity of water bodies in South East Nigeria.

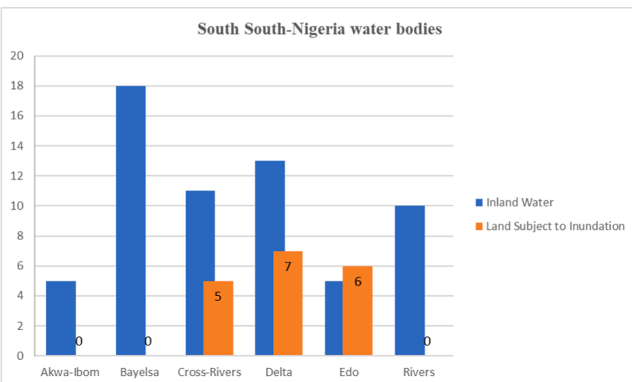

Fig. 6a. Types and capacity of water bodies in South South Nigeria.

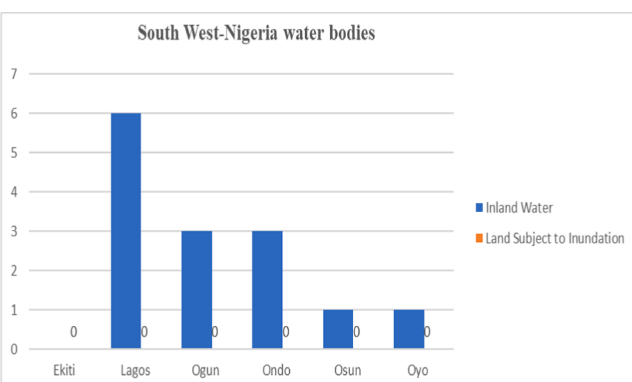

Fig. 6b. Types and capacity of water bodies in South West Nigeria.

and provides a huge potential for various applications of hydro power technology.

The North-Western part of Nigeria has Jigawa state with the largest inland water ways and inundated land areas as shown in Fig. 7b. This is followed by Sokoto state with 27 inland water sites and 18 for Kano and Zamfara. Katsina state is obviously not suitable for SHP generation, thus, other renewable energy sources could be considered.

As expected, Niger, Benue, Nasarawa and Plateau have the highest inland water sites in the North Central, as shown in Fig. 7c, justifying the number of identified sites in the Upper and Lower Benue River basins. These locations play host to Nigeria's oldest and conventional hydro-power generating stations. There is need to develop new run off the river

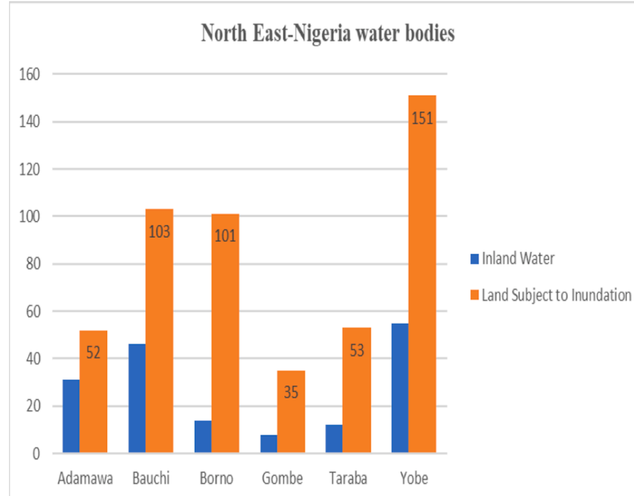

Fig. 7a. Types and capacity of water bodies in North East Nigeria.

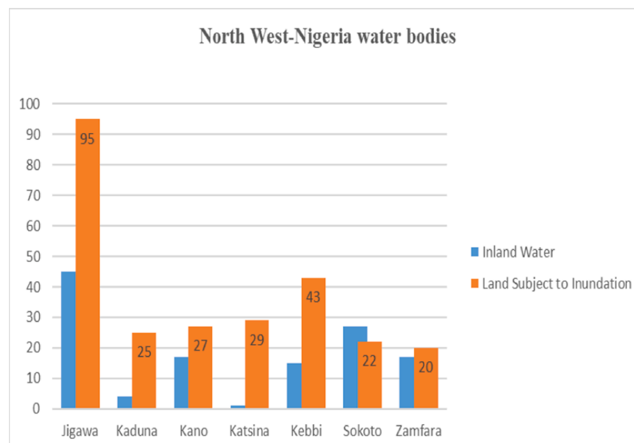

Fig. 7b. Types and capacity of water bodies in North West Nigeria.

schemes and small dam schemes as there are very huge potentials for SHP in Nassarawa state as well as Kogi state.

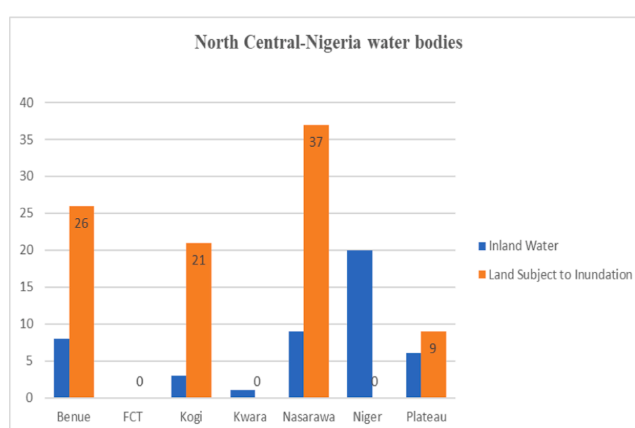

Fig. 7c. c Types and capacity of water bodies in North Central Nigeria.

7. Challenges and opportunities of assessing hydropower sites in Nigeria using ArcGIS

Globally, hydropower has become a key renewable energy source, and Nigeria, with its plentiful water resources, has enormous potential for producing hydropower. But utilizing ArcGIS, a popular GIS program, to evaluate potential hydropower sites in Nigeria poses both obstacles and opportunities. This study examines the difficulties and possibilities related to evaluating hydropower sites in Nigeria using ArcGIS.

Limited data availability is one of the major challenging factors. Comprehensive and current data, such as elevation, river flow rates, precipitation patterns, land cover, and topographic maps, are necessary for the appropriate assessment of hydropower sites. However, in Nigeria, there is sometimes a dearth of trustworthy data, which makes it difficult to accurately assess the potential for hydropower. Another major setback is insufficient technical expertise. It takes specialist knowledge in hydrology, geospatial analysis, and GIS to conduct an exhaustive study of hydropower sites. ArcGIS for site evaluation cannot be used as effectively in Nigeria due to a lack of people with the requisite training and expertise to do complicated hydrological modeling and GIS analysis. Environmental considerations are also not left out as a major drawback in ArcGIS for hydropower location in Nigeria. Hydropower development has the potential to have severe negative effects on the environment, including changes to river flows, modifications to aquatic habitats, and the possible eviction of nearby populations. Integrating ecological and social factors is necessary in order to conduct a comprehensive assessment of the environmental appropriateness of hydropower sites.

A full assessment, however, is hampered by the absence of comprehensive environmental data and issues with stakeholder participation. Moreso, infrastructure needs and accessibility are taken into account while evaluating hydropower locations. The viability of hydropower development is greatly influenced by the availability of sufficient roads, transmission lines, and other infrastructure, particularly in remote places. Finally, for the evaluation of hydropower sites to be successful, there must be an adequate regulatory and policy framework. Clear norms and laws are needed for site selection, licensing, and environmental impact studies in Nigeria's hydropower industry. The evaluation process and the growth of hydropower projects might be hampered by inadequate regulations and inconsistent regulatory frameworks.

On the other hand, ArcGIS provides cutting-edge geospatial analytic capabilities that make it easier to combine and visualize various information. ArcGIS facilitates the discovery of possible hydropower sites by fusing elevation models, hydrological data, land cover information, and other pertinent data. By giving a thorough grasp of the spatial relationships involved, geospatial analysis aids in the making of informed decisions. Besides, ArcGIS may assist in addressing issues with data availability by integrating remote sensing data, such as satellite images. In order to analyze hydrological regimes, topographical features, and land use patterns, remote sensing collects important data on land cover, vegetation, and water bodies. The discovery and assessment of possible hydropower sites are improved by this combination. Again, the ability of ArcGIS to add climate change estimates and scenarios offers the chance to evaluate hydropower sites taking future climate conditions into account. Decision-makers may assess possible resilience in sites and adaptation to changing climatic patterns by including climate data into the study, which will increase the hydropower projects' long-term sustainability. Furthermore, ArcGIS provides tools for participatory mapping and stakeholder engagement, supporting the participation of regional communities, governmental organizations, and other pertinent stakeholders in the assessment process. By including stakeholders, it is easier to identify social and environmental issues, maintain transparency, and encourage inclusive decision-making while choosing a hydropower site.

8. Conclusions and recommendations

Nigeria may unleash its immense hydropower potential and contribute to the advancement of sustainable energy using the ArcGIS strategy to locate hydropower sites. The six geopolitical areas of Nigeria and the several locations that have been assessed as having the essential natural attributes for such projects have all been taken into consideration in this study, which has examined and validated the huge potential for SHP in Nigeria.

From the assessment carried out in this paper, Nigeria's greatest small hydro potentials lie in the North-Eastern part with 151 potential sites for small dam schemes for hydropower generation and 55 inland water sites for large dam schemes in Yobe state. This is followed by the North West with 95 potential small dam sites. These dams could also be harnessed for irrigation purposes to boost agricultural production and contribute to the growth of the economy. The southern part of the country showed the lowest potentials for small hydropower generation and hence prompts the decision makers to shift attention towards other sources of energy such as solar and gas for power generation.

CRediT authorship contribution statement

Benneth Oyinna: Methodology, Software, Data curation, Writing – original draft. **Kenneth E. Okedu:** Conceptualization, Methodology, Data curation, Writing – original draft, Supervision, Writing – review & editing. **Ogheneruona E. Diemuodeke:** Visualization, Investigation. **Lois E. David:** Methodology, Software, Data curation, Writing – original draft. **Isaac O. Negedu:** Methodology, Software, Data curation, Writing – original draft. **Elijah A. Osemudiamen:** Data curation. **Ilhami Colak:** Data curation. **Akhtar Kalam:** Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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