Contents lists available http://www.kinnaird.edu.pk/

Journal of Natural and Applied Sciences Pakistan

Journal homepage: http://jnasp.kinnaird.edu.pk/

STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA) FOR ONSHORE WINDFARM SUITABILITY IN GWADAR, BALOCHISTAN, PAKISTAN

Aamna Naeem[1], Abeer Salman[1], Sofia Baig[1*]
[1]Institute of Environmental Sciences and Engineering (IESE), National University of Sciences and Technology (NUST), H-12, Islamabad

Article Info

*Corresponding Author
Email: sofia.baig@iese.nust.edu.pk

Abstract

Energy crisis has become a major challenge for Pakistan. The day by day increasing electricity shortfall in the country demands for improving the energy mix to overcome the crisis. Pakistan has a great potential for renewable energy that must be utilized. This paper aims to propose and carry out Strategic Environmental Assessment (SEA) for assessing the suitable onshore wind farm site in Gwadar, Balochistan, Pakistan. The district Gwadar in Balochistan has a great potential for wind energy that is still untapped. The methodology of SEA process carried out in this paper involves the 5 main stages: Gathering baseline data and establishing objectives and indicators, assessing potential impacts of onshore wind farms, identifying potential alternatives, selecting best alternative and proposing a monitoring system. SEA process conducted in this paper suggested and concluded that the most suitable alterative is alternative 2- selecting area having minimum impacts on environment, society and economy and the most suitable site in Gwadar district accordingly is found to be Ormara, where the wind profile curve is found to be the greatest. Thus, the proposed SEA process conducted under this paper has found Ormara with greatest wind power potential and minimum impacts in Gwadar, Balochistan. Onshore wind farm in Ormara should be thus set up to generate electric power that will not only overcome the energy crisis in the Gwadar district but also mitigate environmental pollution by promoting renewable energy growth in the region. SEA process proposed in this paper therefore serves as the basis for suitability assessment and analysis of any other onshore wind farms in Pakistan as well as around the globe.

Keywords
Strategic Environmental Assessment, Gwadar, Onshore Wind Farm, SEA Process, Energy Crisis

1. Introduction

Energy crisis in Pakistan has become a major challenge that is impacting the economic and social growth of the country. Being a developing nation, Pakistan is already lagging in various sectors globally and the current rapidly expanding energy crisis is intensifying the issue in the country. Pakistan has major electric shortfall issue with extensive load shedding being experienced in both urban and rural areas.

The major reason behind this energy scarcity in Pakistan is an improper energy mix with heavy reliance on non-renewable energy resources like natural gas and coal (Baloch *et al.,* 2017).

Pakistan has a great potential for various renewable energy sources such as hydel, solar, wind, biomass etc. However, this potential is still untapped. To overcome the energy crisis as well as to shift towards sustainable and clean energy production, Pakistan must invest more in renewable energy projects (Raheem *et al.,* 2016). The generation of power through solar and wind energy in Pakistan is the most sustainable way to meet the ever-increasing electricity demands, overcome the electric shortfall, conserve resources for future generations and tackle the increasing global warming (Aman *et al.,* 2017).

Power generation through wind energy in Pakistan is an effective way to meet the rising energy demands of the country. The largest potential wind corridors in Pakistan lie in the provinces of Sindh and Balochistan (Figure 1). Many wind power plants have already been installed and are operational in different regions of Sindh. In Balochistan on the other hand, these projects have still not been installed. The coastal areas of Balochistan have a great potential for wind power installations, especially in the district of Gwadar (Anwar *et al.,* 2018).

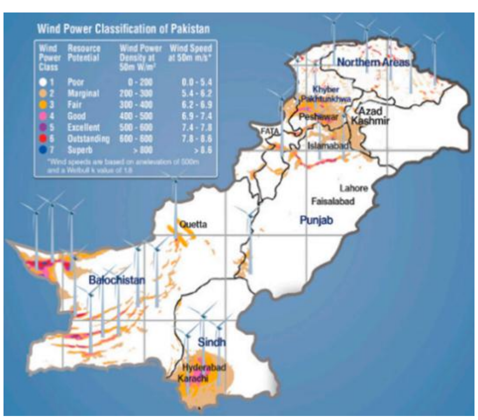

Figure 1: Wind Power Potential Sites in Pakistan- National Renewable Energy Survey (Hulio *et al.,* 2017)

Environmental Impact Assessment (EIA) is well-established and is a mandatory requirement in Pakistan before setting up or starting any big project, however, Strategic Environmental Assessment (SEA) is not well-established and is not a mandatory requirement. The Environment Protection Act of Sindh, KPK and Balochistan have introduced SEA in their laws while the province of Punjab still lacks SEA implementation.

The Balochistan Environment Protection Act 2012 defines SEA as "A system through which components and aspects related to environment are integrated into policies, plans and programs" (BEPA Act, 2012). So far, no Strategic Environmental Assessments have been carried out for any wind energy project in Balochistan. This paper aims to bridge this gap by carrying out SEA process for wind farm installation in the coastal area of Gwadar, Balochistan and proposing the most suitable site to set up wind power project in the district. The potential environmental, social and economic impacts that could be caused by wind farm installation are identified through the SEA process, in order to identify a location most suitable and sustainable for setting up a wind farm to produce electricity that could meet the energy demands within the district. This paper is a proposal for the selection of most preferable site for the construction of windfarm in tehsil of Gwadar, Balochistan, Pakistan by carrying out an effective SEA process.

2. Baseline Data

Established in 1977, the district of Gwadar is a coastal region that lies along the Arabian Sea in Southern Pakistan. It is located in the south-western part of the province of Balochistan, having a total areas of 15,216 sq km. The coastal line of Gwadar district is 620 km long. A deep, warm water port named Gwadar Port is also located in the district. The headquarter of the district is situated in the city of Gwadar. The district comprises of 4 tehsils namely, Pasni, Ormara, Jiwani and Gwadar.

The economic, environmental, and social baseline data of Gwadar district is summarized in Table 1.

Table 1: Baseline Data of Gwadar, Balochistan, Pakistan

Theme	**Quantitative and Qualitative Data**	**Trend**	**References**
Environmental			
Soil	• Moderately, deep, calcareous soils • Perfect drainage • Alluvial deposits of mud, shale, limestone and sand • Alkaline (pH 9) • Low organic matter • Slightly saline (0-1 EC)	Soil pollution is occurring	Fauji Fertilizer Company Limited (FFC) (2018)
Air	• Air Quality Index: 127 • PM 2.5 is the main pollutant with a concentration of 46.2 $\mu g/m^3$	Air pollution particularly caused by PM 2.5 is increasing	IQ Air (2022); Wikipedia (2021)
Climate	• Hot, arid and dry climate • Humid and hot in summers and cold in winters • Average hottest temp. is 31-32°C in June • Average coldest temp. is 18-19°C in January • Mean annual precipitation is 3.54 inches	Climate is becoming warmer	Meteoblue (2022); Wikipedia (2021)
Water	• Saline groundwater • Scarcity of water for irrigation and agricultural purposes • Flood and rainwater are collected to supply drinking water • Ankra and Saji Dams are built • 40 water schemes • 12 water purification plants • 41% houses have no access to water in their vicinity	Clean water is declining leading towards water scarcity in the region	PPAF (2015); Planning and Development Department, Govt. of Balochistan (2011)
Biodiversity	• Enriched with marine animals, birds, and other wildlife around the coast • Wide variety of flora are found • 55 bird species along the Gwadar coastline are found • 10,000 trees planted under Billion Tree Tsunami Project • Mangrove ecosystem is also present	Human activities are endangering wildlife	Ahmed *et al.* (2019); Gabol *et al.* (2018); Express Tribune (2022)
Landscape/Cultural Heritage	• Cultural heritage is not protected by IUCN • Jiwani Coastal Wetland is protected under Ramsar Convention • Astola Island Marine Area is a notified protected area • Buzi Makola is a notified protected	Cultural sites are unprotected and unrecognized	Government of Balochistan; Wikipedia (2019)

	wildlife sanctuary • Hingol National Park also has some part along Gwadar Coastline		
Economic			
Employment	• 40% of the population are employed in agriculture sector • Around 32% of the workers are unskilled	Employment rate is low	PPAF (2015)
GDP growth	• No data available	GDP is expected to enhance up to 30 billion dollars by 2050 under the new GDA-approved master plan	Adnan (2020)
Social			
Population	• Total population of district is 262,253 • 61% population is urban and 39% is rural	Population is increasing	Pakistan Bureau of Statistics (2017)
Human Health	• 55% children are completely immunized • 9 doctors available per 100,000 people • 3 hospitals, 23 Basic Health Units (BHUs) and 14 dispensaries are established • Hepatitis, cholera, malaria are common diseases • 224,550 common illness cases occur in a year span (2009-2010)	Human health status is decreasing and needs to be improved	PPAF (2015); Planning and Development Department, Govt. of Balochistan (2011)
Education	• Male literacy rate is 60% • Female literacy rate is 41% • Overall literacy rate is 51% • Ranked at 61 number nationally under the Pakistan District Education Ranking • Education score is 59	Literacy rate and educational facilities are lacking greatly	PPAF (2015); Wikipedia (2022)

3. Methodology

The SEA process broadly includes a series of steps, including screening, scoping, defining the current environment through the collection of baseline data, assessment of potential environmental impacts, establishing indicators, evaluation and assessment of alternatives, documentation, decision making, as well as monitoring and follow up measures (Finnveden *et al.*, 2003; Iyer, 2017). The stages applied in this paper include (Figure 2):

- Baseline data, objectives, and indicators development
- Identification and assessment of potential impacts
- Identification and assessment of alternatives
- Selection of best alternative

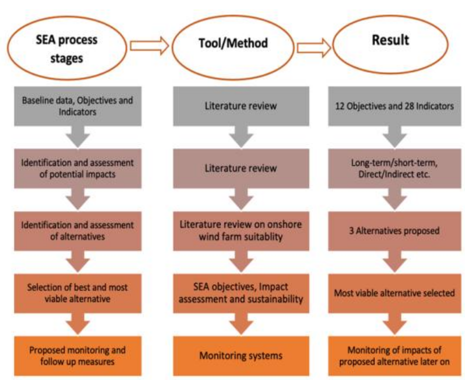

Figure 2: Methodological Framework

3.1 Baseline Data, Objectives, and Indicators

One of the most critical aspects of conducting an SEA is the establishment of a baseline environment against which development can be assessed. The baseline data collected for this study was mainly through secondary sources. A thorough literature review was conducted to establish the current conditions in Gwadar. This included details regarding the area’s topography and soil, biodiversity, water quality, air quality, climate, population, health, cultural heritage sites, economic conditions, etc. Evaluating such variables will allow an in-depth assessment of how the development of wind farms in the region will impact the environment, society, and economy.

SEA objectives and indicators were developed based on a study conducted by Vagiona & Karapanagiotidou (2019) on the Strategic Environmental Assessment of windfarm siting in Greece. It was ensured that the objectives and indicators established for this paper were clear and defined in unambiguous terms, easy to interpret, did not overlap with each other, and were based on available data. The objectives and indicators were divided into three main sections: Environmental, Economic, and Social. Environmental objectives and indicators focused on the state of the environment, economic indicators and objectives focused on interpreting economic conditions of the area, while social indicators and objectives focused on monitoring social change.

3.2 Identification and Assessment of Alternatives

There is currently no framework for identifying alternatives in Pakistan’s legislation. Therefore, the framework used by Vagiona & Karapanagiotidou (2019) was employed for this paper as well. The following alternatives were identified:

Alternative 1: Do nothing. This alternative suggests making no change to the current baseline, and establishing no onshore windfarm sites.

Alternative 2: Onshore windfarm siting only in areas with minimum environmental, economic, and social impacts.

Alternative 3: Onshore windfarm siting in areas with most wind potential, with efforts to mitigate negative impacts that may arise.

The sites proposed for onshore windfarm siting in Gwadar district in this paper are Gwadar, Pasni, Ormara, and Jiwani (Figure 3).

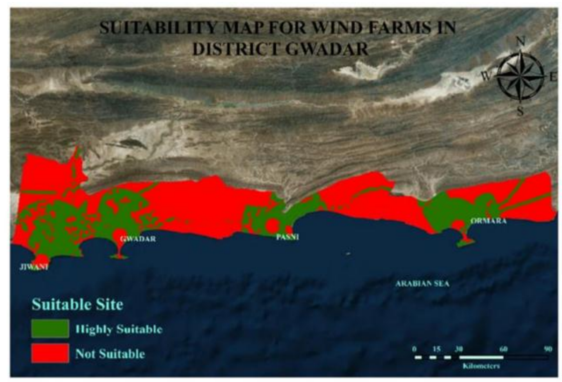

Figure 3: Suitability Map for Onshore Windfarm Siting in Gwadar District (Zahid *et al.,* 2021).

Regions in the color green represent all areas that are suitable for onshore windfarm siting, while those in the color red represent areas that are unsuitable.

3.3 Identification and Assessment of Potential Impacts

The potential impacts of onshore windfarm siting in Gwadar have been identified through literature review conducted for this paper. Factors such as bird migratory routes, aviation areas, impact on local communities, health impacts, etc. were considered. It was also ensured that both direct and indirect impacts of windfarm siting are identified for each proposed site.

The assessment of potential impacts is also a vital component of SEA. In this paper, the potential impacts were categorized in order to assess their significance. The categories included:

- Short-term or long-term impacts
- Direct or indirect impacts
- Construction phase or operation phase impacts
- Positive or negative impacts
- Low-, moderate-, or high-level impacts

Identification of impact significance was done through a matrix-based assessment technique. Impacts were assessed based on their likelihood of occurrence, as well as the extent of the impact on the environment, economy and society. Likelihood of occurrence was assessed based on expert judgment, while the extent of the impacts was assessed based on multicriteria analysis techniques. Impact extent is based on whether the impact is localized (low impact) or widespread (high impact). Each impact was assigned a score based on these two factors. The scores were developed based on a study by Josimović & Pucar (2010), and are detailed in Table 2. The overall score was calculated by adding each score assigned to the likelihood of occurrence and extent of impact.

Table 2: Scores Assigned to Impacts for (a) Negative Impacts and (b) Positive Impacts

(a)

Likelihood of Occurrence	Score	Extent of Impact	Score
Low	1	Low	1
Medium	2	Medium	2
High	3	High	3

The higher the total score, the more negative the impact.

(b)

Likelihood of Occurrence	Score	Extent of Impact	Score
Low	1	Low	1
Medium	2	Medium	2
High	3	High	3

The higher the total score, the more positive the impact.

3.4 Selection of Best Alternative

The criteria used for the selection of alternatives is explained in Table 3.

Table 3: *Criteria for the Selection of Alternatives*

Criteria	Detail
SEA Objectives	To what extent the alternative can help achieve the SEA objectives defined in this paper. Alternatives that satisfy the most objectives were given preference.
Impact Assessment	The level of impact of each alternative. Alternatives with the lowest impact score were given preference.
Sustainability	How well the alternative meets sustainability criteria. Alternatives with the most positive impact on the environment, economy, and society were given preference.

3.5 Proposed Monitoring and Follow-Up Measures

Continuous monitoring of the proposed plan is also crucial in order to prevent or mitigate any adverse impacts that may arise over time. This can be done by frequently evaluating environmental, social, and economic indicators identified in this paper. A recording system should be established to monitor parameters such as air quality, biodiversity, health, etc.

4. Results and Discussion

4.1 Baseline Data, Objectives, and Indicators

The baseline data summarized in Table 1 shows that environmental, economic, and social conditions in Gwadar are unsatisfactory. The SEA objectives developed in this paper aim to improve current conditions in the district. The proposed SEA objectives and indicators were developed on environment, economic and social themes based on literature review (Table 4).

Table 4: *SEA Objectives And Indicators Developed On (A) Environmental, (B) Economic And (C) Social Themes*

(a) Environmental Indicator Name	Objective	Indicators
Biodiversity	Protect habitats and prevent degradation of ecosystems	Number of wildlife species impacted Number of bird species impacted % of Habitat lost Number of plant species impacted
Soil	Prevent degradation of soil quality	Land-use land cover change (%) Change in qualitative and quantitative status of soil (number)
Water Quality	Prevent pollution of water resources and improve water use efficiency	Change in qualitative and quantitative status of water % of water re-used Change in the ecological, physical and chemical parameters of water (numbers and %)
Air Quality	Reduce PM 2.5 concentrations to below 35.4 $\mu g/m^3$	GHG emissions (conc.) PM 2.5 emissions (conc.) Air quality index (IQ Air)
Climate	Use renewable technology to address climate change and reduce temperatures	Per capita CO2 emissions Per capita GHG emissions Exposure level of population to natural disasters

(b) Economic Indicator Name	Objective	Indicators
Employment	Increase employment rates to at least 50% and reduce unskilled labor to 20%	Rate of employment (%) Number of employees in wind energy sector
Energy	Reduce the need to import energy	Produced, utilized, and transmitted electric power from wind (MW) % contribution of wind in energy mix
Economy	Increase shares of wind energy in GDP	Investments in renewable energy (dollars or PKR) % share of wind energy in GDP

(c) Social **Indicator Name**	**Objective**	**Indicators**
Population and Health	Prevent adverse impacts on health by immunizing at least 70% children, increasing number of doctors per 100,000 people to 15, and establishing more hospitals, BHUs, and dispensaries	Number of people getting impacted by wind farms % of people suffering from health issues during construction, operation, maintenance and withdrawal of onshore wind farm People relocated due to wind farm installation Illnesses caused by noise, air quality, water etc. in humans (number or %)
Cultural Heritage Sites and Landscape	Preserve local heritage, culturally significant sites and landscape	Loss and damage caused to cultural heritage, landscape such as protected areas, national parks etc. (number)
Quality of Life	Improve the quality of life of local communities	Access of people to electric power produced by wind (number)
Education	Improve male literacy rate to 70%, and female literacy rate to 60%	Education access of people (number)

4.2 Identification and Assessment of Alternatives

The potential sites selected were assessed on the basis of wind profile curves (Figure 4). These curves represent the windfarm potential in each of the proposed sites, which is the most important aspect of selecting a suitable location. All four sites show different wind potential based on height of wind mills from ground level. Gwadar and Jiwani were not included as alternative sites for windfarm siting due to their low wind potential, as depicted through their wind profile curves (Figure 4a and 4d). Only two sites were compared for their potential environmental, economic and social impacts to determine the most suitable site for onshore windfarm siting in Gwadar district.

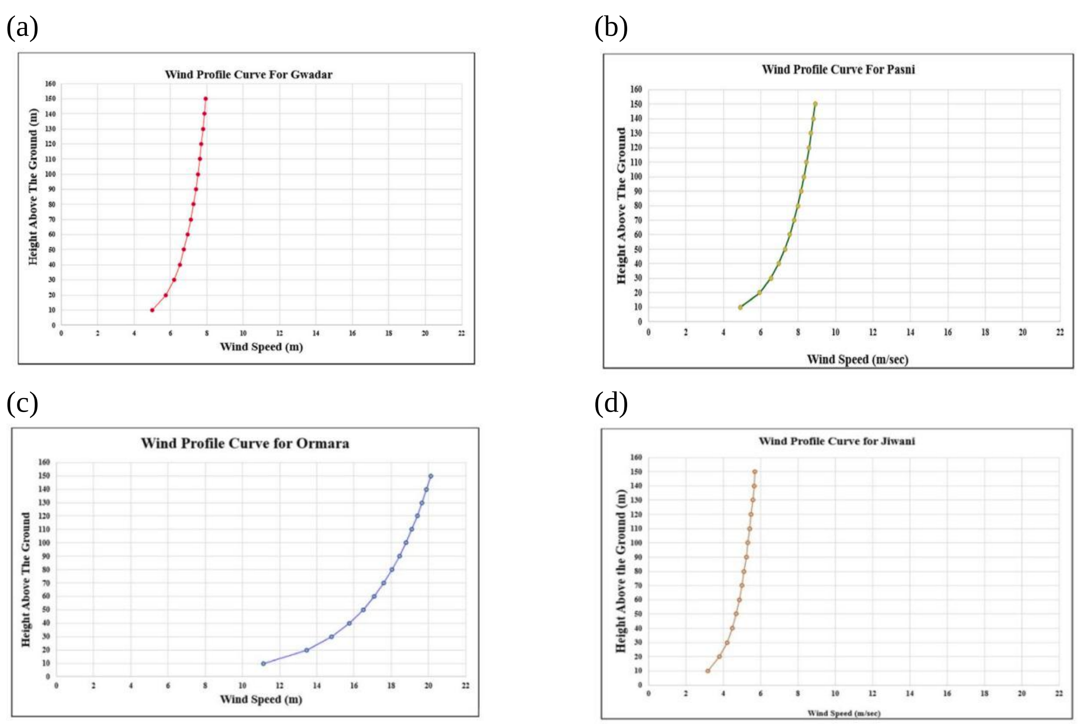

Figure 4: *Wind Profile Curve – (a) Gwadar (b) Pasni (c) Ormara and (d) Jiwani* (Zahid *et al.*, 2021)

4.3 Identification And Assessment Of Potential Impacts

Two sites, Pasni and Ormara, were assessed and compared for their potential impacts in order to identify the most suitable onshore windfarm site. Some of the potential impacts identified and the scores assigned to these two sites are summarized in Table 4.1 (Pasni) and 4.2 (Ormara). These impacts were identified based on various studies (Lima *et al.*, 2013; Siddique *et al.*, 2018; Zahid *et al.*, 2021).

Table 4.1: *Pasni – Impact Assessment Matrix for (a) Negative Impacts and (b) Positive Impacts*

(a)

Impact	Type of Impact	Likelihood of Occurrence	Extent of Impact	Score (Out of 6)
Adverse impact on bird migratory routes	Direct Operation Phase	High (3)	High (3)	5
Redirection of aviation routes	Indirect Operation Phase	Moderate (2)	Low (1)	3
Soil contamination	Indirect Construction Phase	Moderate (2)	Moderate (2)	3
Water quality degradation	Indirect Construction Phase	Moderate (2)	Moderate (2)	4
Degradation of local cultural heritage sites	Direct Construction Phase	High (3)	High (3)	6
Health impacts due to noise	Indirect Construction and Operation Phase	High (3)	Moderate (2)	5
Increase in PM 2.5 concentrations	Direct Construction Phase	Moderate (2)	Moderate (2)	4
Total Score (Out of 42)				30

(b)

Impact	Type of Impact	Likelihood of Occurrence	Extent of Impact	Score (Out of 6)
Improved air quality	Direct Operation Phase	High (3)	Moderate (2)	5
Growth in employment	Indirect Construction and Operation Phase	High (3)	Moderate (2)	5
Reduction of greenhouse gas emissions	Direct Operation Phase	Moderate (2)	Moderate (2)	4
Climate change mitigation	Indirect Operation Phase	Moderate (2)	Moderate (2)	4
Improvement in quality of life	Indirect Operation Phase	Moderate (2)	Low (2)	4
Increased shares of wind energy in GDP	Direct Operation Phase	Moderate (2)	High (3)	5
Total Score (Out of 36)				27

Table 4.2: *Ormara – Impact Assessment Matrix for (a) Negative Impacts and (b) Positive Impacts*

(a)

Impact	Type of Impact	Likelihood of Occurrence	Extent of Impact	Score (Out of 6)
Adverse impact on bird migratory routes	Direct Operation Phase	High (3)	Low (1)	4
Redirection of aviation routes	Indirect Operation Phase	Moderate (2)	Low (1)	3
Soil contamination	Indirect Construction Phase	Moderate (2)	Low (1)	3
Water quality degradation	Indirect Construction Phase	Moderate (2)	Moderate (2)	4
Degradation of local cultural heritage sites	Direct Construction Phase	High (3)	Low (1)	4
Health impacts due to noise	Indirect Construction and Operation Phase	High (3)	Moderate (2)	5
Increase in PM 2.5 concentrations	Direct Construction Phase	Moderate (2)	Moderate (2)	4
Total Score (Out of 42)				28

(b)

Impact	Type of Impact	Likelihood of Occurrence	Extent of Impact	Score (Out of 6)
Improved air quality	Direct Operation Phase	High (3)	Moderate (2)	5
Growth in employment	Indirect Construction and Operation Phase	High (3)	High (3)	6
Reduction of greenhouse gas emissions	Direct Operation Phase	High (3)	High (3)	6
Climate change mitigation	Indirect Operation Phase	High (3)	High (3)	6
Improvement in quality of life	Indirect Operation Phase	Moderate (2)	Moderate (2)	4
Increased shares of wind energy in GDP	Direct Operation Phase	Moderate (2)	High (3)	5
Total Score (Out of 36)				32

4.4 Selection of Best Alternative

According to Zahid *et al.,* (2021) and through SEA process carried out under this paper, Ormara is the best site for onshore windfarm siting as the negative impact score of Pasni (30) is higher than that of Ormara (28), and the positive impact score of Pasni (27) is lower than that of Ormara (32). This makes Ormara a viable site for onshore windfarm siting as its positive impacts outweigh its negative impacts as compared to Pasni. Alternative 2 is selected for this paper, as Ormara is the site with the least environmental, economic, and social impacts.

4.5 Proposed Monitoring and Follow-Up Measures

The monitoring of the effectiveness of the chosen alternative 2 can be performed in a simple and systematic way via the use of objective and indicator system or through the qualitative impact assessment. Monitoring and post-project installation follow up measures are necessary to ensure that the project runs smoothly, and any hazardous impacts are avoided or handled effectively. Establishing a monitoring system is highly crucial in any SEA process.

5. Conclusion and Recommendation

The SEA process carried out in Gwadar, Balochistan concluded that the most suitable and viable site for setting up onshore wind farm is Ormara. The alternative 2 i.e., alternative having least impacts on environment was selected. The objectives, indicators system, qualitative impact assessment and wind profile curves led to the selection of Ormara as the site to install wind farm onshore. The SEA process therefore assisted in effective selection of a suitable and most potential site for wind farm in Gwadar district. By installing wind farm in Ormara and utilizing the full potential of wind energy, enough electric power can be generated to overcome the energy crisis in the district of Gwadar. The SEA process proposed in this paper can thus be used as a basis to carry out SEA for wind farm suitability assessment and selection of the most viable site in other regions of Pakistan as well as around the world. SEA is a very significant process that must be conducted at all costs for any policy, plan, program or even large-scale projects. While EIA has its own advantages, however SEA is also equally important and necessary to be carried out in order to set up any project that has least environmental impacts and most economic, social and environmental benefits. The baseline data, established objectives and indicators, evaluated potential impacts, selected alternative and suggested monitoring system are all stages of SEA process in this paper that are proposed to ensure that renewable energy mainly wind power is flourished and used at its maximum potential to overcome the energy crisis in Gwadar district, Balochistan province of Pakistan.

It is therefore recommended that Government in Pakistan pay heed to the untapped and unutilized potential of wind energy in Ormara, Gwadar. Using this paper as a foundation, the proposed SEA process must be conducted and onshore wind farm in Ormara be set up to bridge the gap between energy demand and supply as well as promote environmental, economic, and social growth in the region.

6. References

Adnan Aamir. (2020). Gwadar Port: New Dubai or pie in the sky? The Interpreter. https://www.lowyinstitute.org/the-interpreter/gwadar-port-new-dubai-or-pie-sky

Ahmed, I., Haroon, A., Khan, M. N., Asadullah, H. S., Nadeem, A., Saeed, F., & Buzdar, M. A. (2019). 68. Occurrence and biodiversity of marine yeast in mangrove ecosystem of Shabi Creek, Gwadar-Pakistan. Pure and Applied Biology (PAB), 8(1), 680-687.

Aman, M. A., Ahmad, S., & Mehr-e-Munir, M. A. (2017). Solutions of current energy crisis for Pakistan. International Journal of Computer Science and Information Security (IJCSIS), 15(5).

Anwar, N. U. R., Mahar, W. A., & Khan, J. F. (2018, November). Renewable energy technologies in Balochistan: Practice, prospects and challenges. In Proceedings of the 5th International Conference on Energy, Environment and Sustainable Development (EESD) 2018. Mehran University of Engineering and Technology (MUET). https://hdl.handle.net/2268/229334

Baloch, M. H., Abro, S. A., Sarwar Kaloi, G., Mirjat, N. H., Tahir, S., Nadeem, M. H., & Kumar, M. (2017). A research on electricity generation from wind corridors of Pakistan (two provinces): a technical proposal for remote zones. Sustainability, 9(9), 1611. https://doi.org/10.3390/su9091611

Balochistan EPA. (2012). Balochistan Environmnet Protection Act. https://bepa.gob.pk/balochistan-environmental-protection-act-2012/

Express Tribune. (2022). Tree plantation drive kicks off in Balochistan. https://tribune.com.pk/story/2283977/tree-plantation-drive-kicks-off-in-balochistan

Fauji Fertilizer Company Limited (FFC). (2018). District Soil Survey Reports, Soil Survey of Pakistan Farm. Advisory Centers, Fauji Fertilizer Company Limited (FFC) http://www.ffc.com.pk/wp-content/uploads/5.-DISTRICT-PROFILES-1.pdf

Finnveden, G., Nilsson, M., Johansson, J., Persson, Å., Moberg, Å., & Carlsson, T. (2003). Strategic environmental assessment methodologies—applications within the energy sector. Environmental Impact Assessment Review, 23(1), 91-123. https://doi.org/10.1016/s0195-9255(02)00089-6

Gabol, K., Ahmed, W., Rahim, A., Shams, Z. I., Zain, Z., & Batool, A. (2018). Status and diversity of coastal avian fauna in Gwadar peninsula, Balochistan. http://hdl.handle.net/1834/40832

Government of Balochistan. Protected Areas of Balochistan. https://bfwd.gob.pk/protected-areas-of-balochistan/?print=print

Hulio, Z. H., Jiang, W., & Rehman, S. (2017). Technical and economic assessment of wind power potential of Nooriabad, Pakistan. Energy, sustainability and Society, 7(1), 1-14. DOI:10.1186/s13705-017-0137-9

IQ Air. (2022). Air quality in Gwadar. https://www.iqair.com/pakistan/balochistan/gwadar

Iyer, V. (2017). Strategic Environmental Assessment (SEA) Process for Sustainable Mining and Mineral Management Development. Oalib, 04(04), 1-28. https://doi.org/10.4236/oalib.1103422

Josimović, B., & Pucar, M. (2010). The strategic environmental impact assessment of electric wind energy plants: Case study 'Bavanište' (Serbia). Renewable Energy, 35(7), 1509-1519. https://doi.org/10.1016/j.renene.2009.12.005

Lima, F., Ferreira, P., & Vieira, F. (2013). Strategic impact management of wind power projects. Renewable And Sustainable Energy Reviews, 25, 277-290. https://doi.org/10.1016/j.rser.2013.04.010

Meteoblue. (2022). Simulated historical climate & weather data for Gwadar. Meteoblue. Retrieved 1 June 2022, from https://www.meteoblue.com/en/weather/historyclimate/climatemodelled/gwadar_pakistan_1177446.

Pakistan Bureau of Statistics. (2017). Population Census of Pakistan. https://www.pbs.gov.pk/sites/default/files/population/2017/balochistan_district_wise.pdf

Planning and Development Department, Govt. of Balochistan. (2011). District Development Profile. Planning & Development Department, Government of Balochistan in Collaboration with UNICEF.

https://cms.ndma.gov.pk/storage/app/public/publications/January2021/iiycLcA9qr83yCfNKDGo.pdf

PPAF. (2015). Development Profile of Gwadar District. Situation Analysis & Baseline Surveys For Poverty Reduction through Rural Development in KPK, FATA & Balochistan. AASA Consulting in collaboration with GRHO.

Raheem, A., Abbasi, S. A., Memon, A., Samo, S. R., Taufiq-Yap, Y. H., Danquah, M.

K., & Harun, R. (2016). Renewable energy deployment to combat energy crisis in Pakistan. Energy, Sustainability and Society, 6(1), 1-13. DOI 10.1186/s13705-016-0082-z

Siddique, S., Wazir, R., Zahra, A., Iqbal, N., Javed, A., Ali, M., & Ilyas, F. (2018). Technical and Financial Analysis for a 50MW Wind Farm in Pasni, Balochistan. 2018 International Conference on Power Generation Systems and Renewable Energy Technologies (PGSRET). https://doi.org/10.1109/pgsret.2018.8685937

Vagiona, D., & Karapanagiotidou, X. (2019). Strategic Environmental Impact Assessment for Onshore Windfarm Siting in Greece. Environments, 6(8), 94. https://doi.org/10.3390/environments6080094

Wikipedia. (2019). Jiwani Coastal Wetland. https://en.wikipedia.org/wiki/Jiwani_Coastal_Wetland

Wikipedia. (2021). Climate of Gwadar. https://en.wikipedia.org/wiki/Climate_of_Gwadar

Wikipedia. (2022). Gwadar District. https://en.wikipedia.org/wiki/Gwadar_District

Zahid, F., Tahir, A., Khan, H., & Naeem, M. (2021). Wind farms selection using geospatial technologies and energy generation capacity in Gwadar. Energy Reports, 7, 5857-5870. https://doi.org/10.1016/j.egyr.2021.08.165