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Locating the best place to build a desalination plant with artificial intelligence (Chabahar study area, Iran)

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Abstract

Due to the increase in world population, water consumption will increase significantly It has become one of the main problems of drinking water supply. On the one hand, compensable water resources are declining, and on the other hand, in some areas due to drought due to lack of rainfall and lack of access to surface and groundwater resources, drilling wells does not help to solve this problem. Therefore other methods such as water desalination or desalination should be considered. In Iran, due to the climatic conditions of the country, the need to produce drinking water in low capacities, for sparsely populated and remote areas, is an issue that has received less attention so far. While in arid and desert areas, which are large in the central regions of Iran, on the one hand, the need for fresh water is one of the main problems of the people of these areas and on the other hand, solar energy with appropriate radiation intensity in this area available. Artificial intelligence is expanding in all sciences and all walks of life, and this technology is advancing day by day. Scientists hope that thanks to recent advances in artificial intelligence, control and monitoring methods for water treatment plants will be simpler and cheaper than before. This research, uses artificial intelligence and criteria such as the topography of the region, the distance between Chabahar and Konarak, and type of land use. Distance from communication roads, distance from the river, proximity to water areas (beach) to the location of desalination has been done.

1. Introduction

Recycling effluents, rainwater collection, bottled water, and cross-country pipelines are some of the alternatives. There are advantages and disadvantages to each of these strategies. Desalination is a low-cost approach of supplying drinking water to places where there is water scarcity. Desalination is the most well-known method arising from changes in both the availability and demand for freshwater supplies, both of which are anticipated to increase exponentially in future years (Bremere, 2001).

One of the most promising techniques to deal with water shortages is desalination which converts mildly saline or seawater to drinkable freshwater (Grubert, et al., 2014; Ziolkowska., 2015).

In terms of sea areas, the largest number of desalination plants exist in the Gulf with a total seawater desalination capacity of approximately 12.1 Mm3/d—or about 44% of the worldwide daily production. The largest producers of desalinated water in the Gulf (and worldwide) are Saudi Arabia (25% of the worldwide seawater desalination capacity, of which 11% are in the Gulf region, 12% in the Red Sea region, and 2% in unknown locations), the United Arab Emirates (23% of the worldwide seawater desalination capacity), and Kuwait (6%)) El-Ghonemy, 2012).

Access to appropriate and sustainable water resources is one of the most important factors for a country's long-term development. This is especially critical in the Middle East and countries surrounding the Persian Gulf because of its placement in the world's dry belt. Desalination is one of the human techniques to deal with a water shortage, and it is a technology that the Arab countries of the Persian Gulf have employed to supply water. Despite its unlimited access to seawater in the Persian Gulf and the Sea of Oman and the great potential for water desalination, Iran has not been effective at using it, and continues to have water shortages and secondary issues, making a barrier to increasing economic progress. Despite the high efficiency of water

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desalination, finding a suitable location for desalination plants is one of the most difficult challenges facing water basin planners and managers. They must, in accordance with the principle of low-consequence development, inflict the least environmental damage on the environment, and at the same time, take into account future needs in accordance with the framework of sustainable development without destroying resources. Many studies have been conducted around the world and in Iran to develop optimal methodology and to identify the most suitable sites for desalination. There have been studies on the selection of suitable sites for desalination plants, which include solar desalination plants in Türkiye (Aydin et al., 2020).

2. Methodology

2.1. Study area

Chabahar is one of the southeastern cities of Baluchistan, Iran and the only ocean port in the country, which is located on the shores of the Makran Sea and the Indian Ocean. Chabahar port is of great importance due to its strategic location, which is the closest way for landlocked countries in Central Asia to access open waters. It is located at 60 degrees and 37 minutes east longitude and 25 degrees and 17 minutes north latitude. It is bounded on the north by Iranshahr and Nikshahr counties, on the south by the Oman Sea, on the east by Pakistan and on the west by the provinces of Kerman and Hormozgan. The area of Chabahar city is about 9739 square kilometers, the height of this city is 7 meters above sea level and it has 130 kilometers of land border and about 115 kilometers of water border in the Oman Sea. The population of Chabahar city is 291910 people.

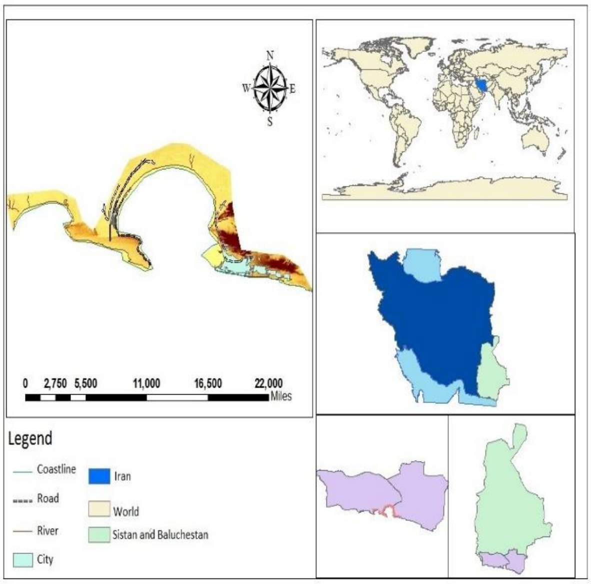

Figure 1. Geographical location of Chabahar in southeastern Iran

2.1.1. Artificial neural network

An artificial neural network is an idea for processing information that is inspired by the biological nervous system. Like the human brain, it processes information. In a nervous system, neurons (nerve cells) are known to be the main processing element for Problem solving works in unison: ANNs, like humans, learn by example and transfer knowledge, or the law behind experimental data, to the network structure by processing it into experimental data. It is called intelligent because it learns general rules based on calculations on numerical data or examples. Each network consists of at least two layers, an input layer and an output layer. At the same time it can have several hidden layers between the input and output layers, usually a single neuron with multiple inputs alone is not enough to solve the problem.

2.2.1. How to prepare data in GIS software

Before building a neural network, data needs to be prepared. First, we select the desired parameters based on the project theme. After selecting the effective parameters, data collection is needed. The effective parameters for identifying the area need desalination water, inter-city distance, geological structure, land use, proximity to communication roads, distance from the river, and proximity to water areas (Beach).

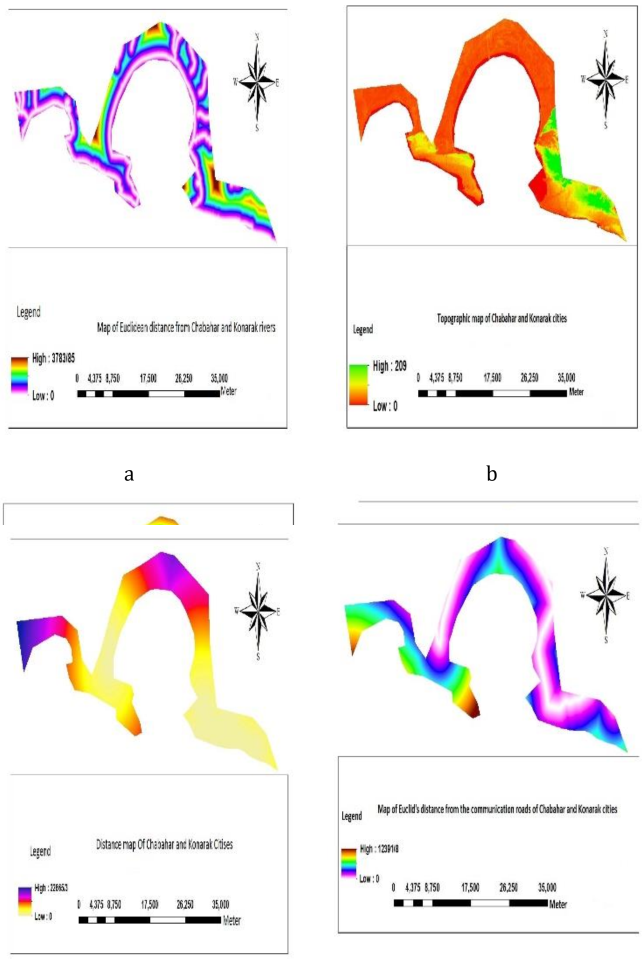

Figure 2. Map prepared from data in GIS software(a), inter-city distance (b), geological structure (c), proximity to communication roads (d), land use (e), proximity to water areas (Beach). Are. (f) proximity to communication roads

2.2.3. Compiling an artificial neural network

The compilation is essentially the application of a descending random gradient to the entire neural network. optimizer is a method for optimizing weights, such as adam, rmsprop .... The first parameter is an algorithm that is to be used to obtain the optimal set of weights in the neural network. . There are several types of these parameters. One of the most effective algorithms for this is Adam. The second parameter is the loss function in the stochastic reduction gradient algorithm. Because classes are binary, the binary-crossover loss is used. Otherwise, categorical_crossentopy is used. The final argument is the criterion used to evaluate the "model". In this example, "(accuracy) is used to evaluate the model. As a result, we fit the data to our model.

2.2.4. Regularization term

Small changes in input size to changes in output can solve these problems Used with a common term in harms. This is the middle that measures the banks in the neural network. Adding it causes damage can reduce our weight and bias. L1, L2 are used. In weight L1 is absolute, L2 in weight is multiplied by two

Overfitting in machine learning occurs when the model learns the details of the noise in the dataset and thus performs poorly on the test dataset. This happens when there is a big difference between the accuracy of the test set and There is a training set or when there is a high variance when applying cross-validation K fold is available. In artificial neural networks, this problem is addressed using a method called "Dropout Regularization". Dropout Regularization works by accidentally deactivating some neurons in each repetition of training to prevent them from becoming too independent of each other.

```
model_3 = Sequential ([Dense (10, activation='sigmoid',
t_shape= (9,)), kernel_regularizer=regularizers.l2 (0.01),
inpuDropout (0.3),
=regularizers.l2 (0.01)), Dense (5, activation='relu',
kernel_regularizer Dropout (0.3), (1,
activation='sigmoid', Dense
kernel_regularizer=regularizers.l2 (0.01)),])
model_3.compile
(optimizer='sgd',loss='binary_crossentropy',
metrics= ['accuracy'])
hisr_3=model.fit(x_train,y_train,batch_size=10,epochs=1
00, ,validation_data=(x_val,y_val))
```

2.2.5. Adjust parameters

Once the desired accuracy is achieved, the parameters can be adjusted for higher accuracy. Grid search enables the user to calculate various parameters to get the best parameters.

```
from sklearn.model_selection import GridSearchCV
```

Also, the make_classifier function must be edited according to the following tutorial. A new variable called optimizer is also created to add more than one optimizer to the params variable.

```
def make_classifier(optimizer):
() classifier=Sequential
classifier.add(Dense(10,kernel_initializer =
"uniform",activation='relu'))
classifier.add(Dense(1,activation = 'relu'))
classifier.compile(optimizer=optimizer,loss =
"binary_crossentropy",metrics = ["accuracy"])
return classifier classifier = KerasClassifier(build_fn =
make_classifier)
params={'batch_size':[5,10],'nb_epoch':[1,10],
'Optimizer':['adam','rmsprop'] }
```

batch size: The number of courses and the optimizer function is among these parameters.

rmsprop and adam: Here they are as optimizers.

Grid Search is then used to test these parameters. Grid Search function from the parameter estimator that was defined. Demands scoring and number of k-folds

```
grid search= GridSearchCV (estimator=classifier,
param_grid= prams, scoring='accuracy', cv= 10)


grid search= grid search.fit (x_trian, y_trian)
```

You can get the best selection of parameters using the best_params from the grid search object. Similarly, best_score is used to get the best score.

```
best_param= grid_search.best_params_best_param
    {'batch_size': 5, 'epochs': 10, 'optimizer': 'rmsprop}'

best_accuracy=grid_search.best_score_best_accuracy
0.812
```

To predict new data:

```
Kol=pd.read_csv("/home/khu/Downloads/dade20.csv"
)
```

Calling data that has no output and the output of this data is predicted using training data

```
test_x=data1.drop (['X','Y', 'class', 'SUTIABILIT'],
axis=1).values test_x
x_kol=kol.iloc [: 2:10]
x_kol=x_scale.fit_transform(x_kol)
kol_prdict=model. Predict (x_kol)
kol_prdict
```

3. Results

Neural network training based on trial and error so that the optimal network arrangement is achieved by changing the number of hidden layers and neurons of that type of moving function of training algorithms and the number of repetitions of the training stage to calculate the output coefficient. The optimal model is when the neural network performs the best fit with the least error (Saadi et al., 1399). 2% loss performance. The line diagram (1,2) shows the correlation between the loss function and the accuracy of the training and validation data.

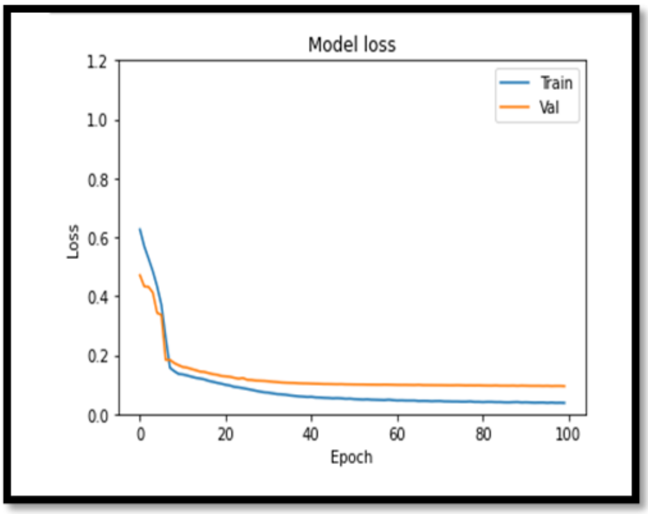

Figure 3. Correlation diagram of the function of educational data loss and validation

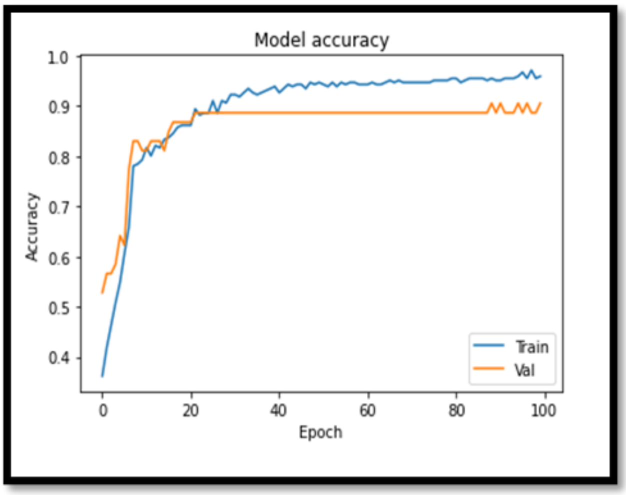

Figure 4. Correlation between the accuracy and validity of educational data

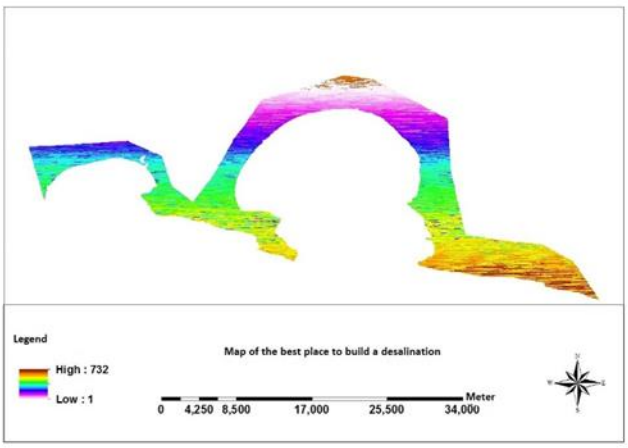

Figure 5. Map of the best place to build a desalination plant

4. Conclusion

Today, with the shortage of fresh water, humans have turned to use other available non-fresh water sources such as seawater and oceans, and in this regard, new technologies in the field of seawater treatment and desalination have been formed. Due to its proximity to the waters of the Oman Sea and the Persian Gulf, Iran has a good potential for the development of desalination units and the production of fresh water for industrial, agricultural, and even drinking purposes. It is necessary to increase and develop desalination units. It requires compliance with environmental laws and standards to prevent the increase of pollutants in the marine environment due to the effluent of these units. According to the results and output of Figure 3, the best places to build on the map according to the criteria are dark yellow to dark red.

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