DURABILITY AND RESILIENCY IMPROVEMENT IN MAZANDARAN ELECTRICITY DISTRIBUTION COMPANY AGAINST STORM

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ABSTRACT

The incidence of adverse weather conditions and natural disasters have led to the imposition of widespread damages and outages in distribution network, while the number and severity of these events has been growing in recent years mainly. These outages are followed by school closures, disruption of service in emergency centres, huge financial losses to the industry and the economy, and other problems. This article reviews the rules to enhance network resiliency during bad weather conditions to reduce impacts of coercive events. Reduction of average power restoration time is named a main priority in power distribution planning and operation. Mazandaran, Iran power distribution network was taken as the study case, taking the regional natural and climatic situation into consideration.

INTRODUCTION

Given that Iran is an accident full state where many natural disasters such as floods, earthquakes and hurricane occur and according to meteorological predictions, more sever occurrences are on the way. This makes reviewing the retrofitting of distribution networks and increasing flexibility necessary for increasing network restorability after natural disasters. These threats may turn out to be crisis in absence of effective management [1-2]. Mazandaran Electricity Distribution Company (The MEDC) is responsible for preparing electricity service for over 1.3 million customers in northern region of Iran. In terms of geography, including numerous mountainous and forested areas that have been affected by the storms and various natural disasters.

Due to the increase in natural disasters in recent years and recent warnings from the Meteorological Agency, areas covered by MEDC will also be included in the increase of storms and disasters in future. It is necessary to retrofit the network before the storm and the restorability after taking serious action to be taken of storms and natural disasters [3-5]. In addition to the Meteorological Agency reports referring to the outage records and blackout events logs in MEDC shows increases in unplanned outages due to inclement weather.

Figure 1 shows the average number of events per feeder introduced by climate effects for 6 years where an increasing trend is seen.

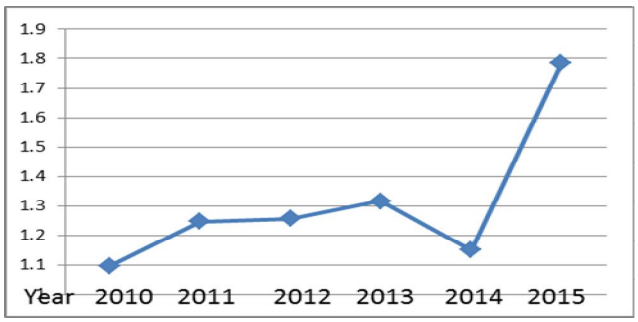

Fig.1. Average number of outages per feeder induced by climatic events in MEDC network

A storm with a speed of over 90 km/h along with heavy rain was the latest one in Mazandaran region on Oct. 2015 which has imposed sever damages. Next figure shows the falling trees on medium voltage network in storm of Oct. 2015.

Figure 2: Falling of trees on medium voltage network in storm of oct.2015

In this article we summarize the observations made in this storm, in order to retrofit the network and enhance the ability of the restoring the network after the storm. The weak points of network are identified and strategies to retrofit the network as well as increasing the durability of the network before the storm and the resiliency enhancement of the network at the time of the storm are presented. These solutions are in the areas of operation of the network, design, supervision and standards, revising standards according to the changes in pollution zoning adapted for new climatic conditions, optimal management of the crisis, secure communications platforms, using new technologies, etc. It also uses GIS platform for implementing network revaluation and old network elements identification by taking the layers of river and flood faults into account. Network planning and enhancement was done for the addressed network elements based on the results of this analysis. Elevation layers were used to identify blind coverage

spots of the communication pints in times of crisis in addition. The results were considered in strengthening communication system by optimal placement of telecommunication repeaters to enhance communication network coverage.
This paper explains the observations and practical experience dealing with the storm in Mazandaran electricity distribution network and the results have been used to increase the strength and capabilities of the network durability and restorability. Problems are classified according to regional climate issues and appropriate solutions are offered. Next figure shows the overall approach for durability and resiliency improvement in MEDC.

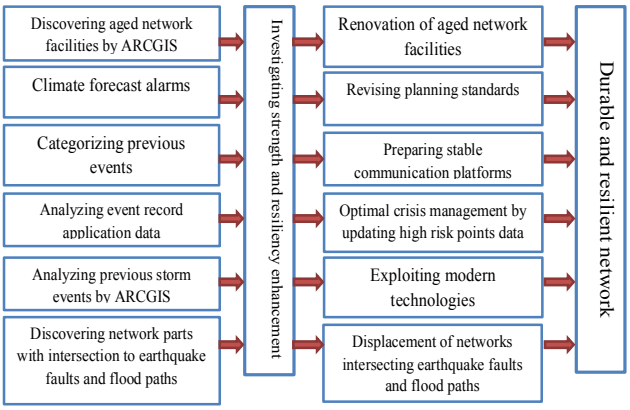

Fig.3.Durability and resiliency improvement approach in MEDC

IDENTIFY WEAKPOINTS IN NETWORK

By collecting reports of 16 sub-companies of MEDC and visiting the places of incidents, efforts have been made to classify the causes of accidents to provide solutions to prevent similar incidents. According to the final classification made, causes of accidents during storm events are as follows in MEDC:

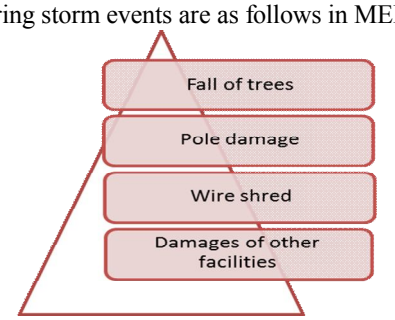

Fig.4. Categorizing causes of damage

On the other hand, parts of the network due to equipment wear and tear and also placing in the floods, faults, earthquakes path and..., have high potential vulnerabilities.
GIS was used to identify network elements intersecting flood-routes and earthquake faults as the weak points of the network. These network parts were included in the priority of network renovation and strengthening program.

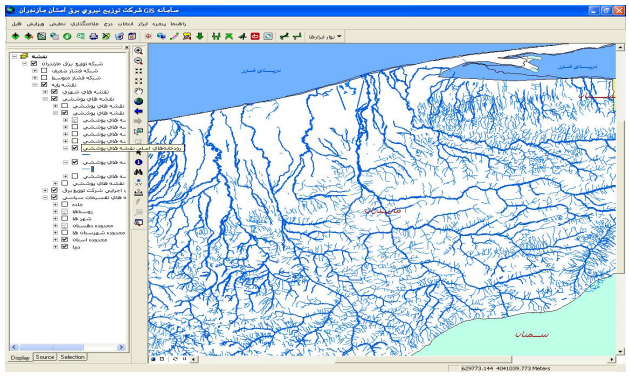
Figure 5: Identify the electrical network intersecting the river runs using GIS

The life-time of network elements was considered in GIS- The life-time of network elements was considered in GIS-based revaluation of MEDC network equipment and those aged ones were also put in the priority of replacement and renovation. Figure 6 shows the average age of network elements in the 16 sub-companies of MEDC with color legend. The map has been produced based on the latest GIS-based revaluation of MEDC network elements.

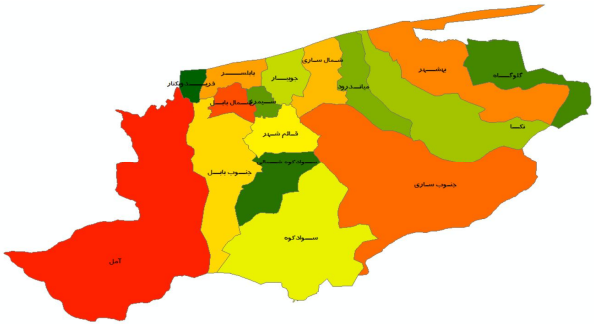
Figure 6: Categorizing MV-poles in MEDC sub-companies based on their average age

DURABILITY AND RESILIENCY IMPROVEMENT STRATEGIES IN MEDC

Mazandaran Electricity Distribution Company's strategy of promoting resilience and restorability according to survey conducted flexibility includes the following topics:
• Managed pruning of trees
• Revising the standards for producing new concrete poles and the maintenance of existing ones
• Preparing standby equipment
• Revising and improving design standards
• Use of automation systems to increase network restorability and reconfiguration
• Improving communication coverage in times of crisis

Managed pruning of trees

According to the Caspian region, which mainly consists of forest and tree cover is, most of the electricity distribution network is already involved with tree or a high potential to create it. According to statistics extracted from the software records the events and what the real world is engaged in distribution networks with trees, it can be concluded that the priorities of Mazandaran electricity distribution companies on issues relating to accidents caused by falling trees and branches deal with the network.
Accounting for pruning operations in Mazandaran electricity distribution companies, the first step is to prepare a spatial database and descriptive of trees has been involved with the network. With the addition of fields related to trees, complete descriptive information such as tree type, tree height.
This work provide full banking from network information involved with the pruning of trees in planning for timely action and appropriate to the season pruning will help. In this regard the signing of a memorandum of understanding with the concerned municipalities and agencies, Good cooperation with regard to pruning operations by Mazandaran electricity distribution companies and is ongoing. Next figure shows the Electricity Network Engaged with tree in GIS environment.

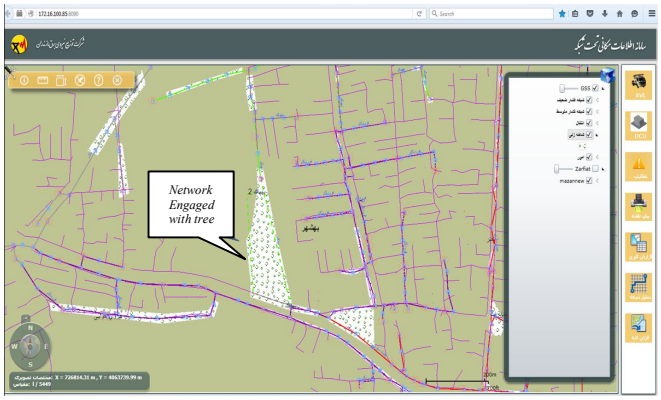

Figure 7: Electricity Network Engaged with tree in GIS environment

Revising the standards for producing new concrete poles and the maintenance of existing ones

Given the high number of falls and fractures of the pole of the recent storms, the following new requirements to retrofit existing pole and enhance the quality of new pole has been adopted:
• Promoting wooden pole to the pole of Reinforced Concrete
• If necessary the deployment harness at the pole who are under tensile force.
• Use drums and concrete pole for installation on all lands loose Mazandaran province
• Monitoring the use of higher quality raw materials in the manufacture of concrete foundation

Preparing standby equipment

Due to bad weather in many hundred percent damage to equipment distribution network enters, and continue the process of electrification will face several days with interruptions only way to use standby equipment, such as generator, transformer and equipment are ready to work.
With the revision of the number of equipment standby power supply capability is somewhat urgent in crisis conditions have been strengthened, given the financial constraints and the importance in this regard to work there.


Figure 8: View of standby equipment

Revising and improving design standards

Considering that some cities are completely on the sidelines and coastal area pollution and sprinkle sand beach on the equipment will work and other regions are mountainous and forested plain areas, it is essential to distinguish between pollution maps of the cities with the new climatic conditions considered Which can lead to increased levels of standard lines and lines designed to impose stricter conditions.
It is also essential special review of the overload coefficient of ice, wind and storms in accordance with IEC60826. Next figure shows Different climate zone based on new climate changes.

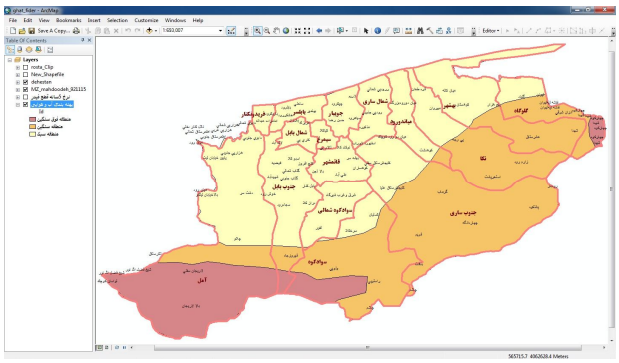
Figure 9: Different climate zone for higher standard design

Improving communication coverage in times of crisis

With regard to the areas covered by the distribution network Mazandaran and elevation difference among regions is mountains and trees which included numerous communication blind spots that will be several times the importance of the issue in the event of blackouts. So the master plan using the tools available in GIS and by taking various areas of elevation profiles where needed to install wireless amplifiers have been identified. Next figure shows the usage of different layers in the placement of wireless amplifier.

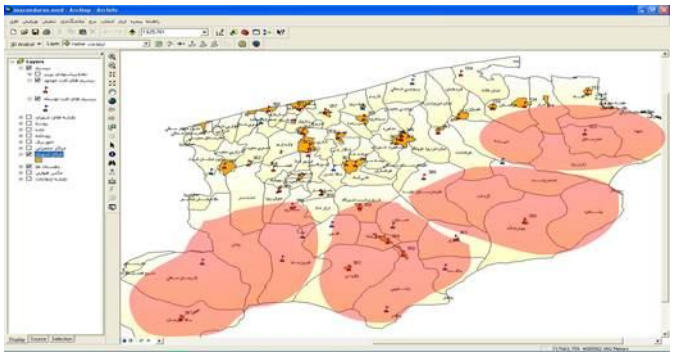

Figure 10: Elevation layer in the placement of wireless amplifier

CONCLUSION

MEDC network encounters several natural disasters due to the climatic nature of the region. Network weak points were decided at the first step for the purpose of increasing network resiliency and restorability during and after storms and floods.
Strategies and measures were introduced to achieve restoring targets after the shortest possible time. Figures 11-12 show the overall solution for network resiliency and durability enhancement.

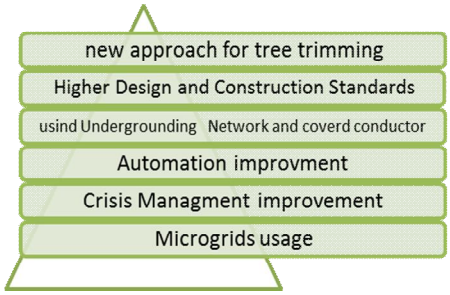

Fig.11. Overall network durability enhancement solution

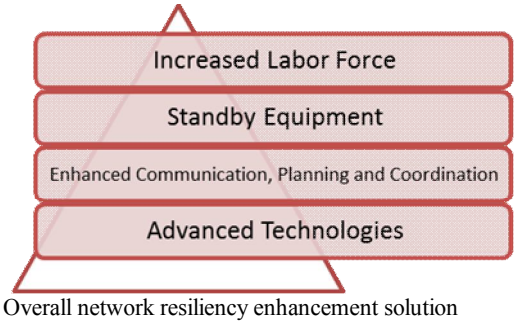

Fig.12. Overall network resiliency enhancement solution

Finally, the full implementation of strategies to achieve the following objectives will be charged:
• Increased resiliency of distribution networks to deal with inclement weather
• Increased restorability and prevented widening blackouts in case of events
• Increased network reliability and improvement in operation
• Reduced economic losses caused by the blackouts introduced by natural disasters
• Increased customer satisfaction

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