INNOVATIVE SOLUTION OF SAFETY CORRIDOR DESIGN FOR OVERHEAD LINES: INCREASING RESILIENCE TO EXTREME WEATHER EVENTS WHILE PROVIDING ENVIRONMENTAL BENEFITS – RESULTS

Maria Inês VERDELHO
EDPD – Portugal
mariaines.verdelho@edp.pt

Ricardo PRATA
EDPD – Portugal
ricardo.prata@edp.pt

Silvestre PEREIRA
EDPD – Portugal
silvestre.pereira@edp.pt

Alcides COUTO
EDPD – Portugal
alcides.couto@edp.pt

Miguel VIEIRA
FloraSul
miguel.vieira@florasul.pt

Vítor TOMÁS
EDP Labelec
Vitor.tomas@edp.pt

ABSTRACT

This paper presents the main end actions developed in Louriçal Pilot Project, where it was implemented the Risk Management Buffer (RMB) concept/approach, consisting in the extension of the existing safety corridors in HV/MV lines. This approach aims at increasing line resiliency, based on a risk assessment for MV and HV overhead lines, in order to avoid falling or contact of trees located outside the safety corridors, particularly when associated with Extreme Weather Events, while providing environmental benefits.

INTRODUCTION.

This paper presents the main end actions developed in Louriçal Pilot Project, where it was implemented the Risk Management Buffer (RMB) concept as introduced in [1] and developed in [2].

EDP – Distribuição (EDPD), the Portuguese DSO, operates MV and HV overhead lines that are established within forests (8,300 km inside protected areas for nature conservation) and, therefore, exposed to hazards like forest fires and damages caused by tree falling, particularly under extreme weather events.

Safety corridors have revealed to provide an inadequate protection during extreme weather events (EWE), Portugal has experienced several EWE recently, which had a negative impact on the reliability of the distribution network. In 2013, one EWE originated interruptions with an Equivalent Interruption Time (proportional to interrupted installed capacity) of 30 minutes and direct total cost of € 6 million. Louriçal was one of the regions most affected by this storm.

The RBM was created and is now being tested through a Pilot Project implemented at Louriçal. In this paper we focus on the main actions developed, the difficulties encountered, the solutions implemented and community involvement in this project with more than forty interactions.

We found to reduce the risk by increasing the network resilience of Louriçal area of extreme events, based on a cost benefit analysis, assuming a certain risk upon analysing several scenarios with different costs and time horizons, the solutions and community involvement in this project.

CASE STUDY RESULTS

We achieved to follow all the steps of RMB Process (as shown in Fig.1), improving the data definition and the landowner interactions.

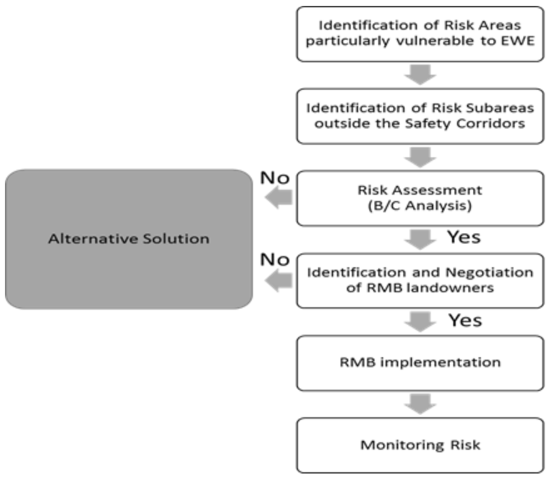

Fig. 1 RMB Process.

Summing up, we identified the risk areas particularly vulnerable to EWE, which were identified in [3], also considering other potentially aggravating conditions impacting on overhead lines, including the ones described in the Forest Fire Risk Chart and the Natural and Technological Hazard Map [4].

Then we identified the risk subareas outside the safety corridors – *RMB* - using an innovative data analysis based on LiDAR technology and land use cartography. If the intervention in *RMB* was cost effective we identified the landowners on that areas, we conducted the negotiation and finally we intervened in the areas using the good practice manuals [5] and [6].

The integrated innovative processing of LAS files (LIDAR) and land use cartography, performed by the partner named EDP Labelec, a company that offers specialized services in the electrical power and environmental areas, was used to prepare and support characterize RMB in network Louriçal area. The RMB is defined by the georeferenced location the size and species of trees outside the safety corridors that might fell off to the line. A SGIF[1] Platform was created to interact and share information with our internal staff and our service providers.

The information displayed through the SGIF Platform allows the quick identification of the levels of risk and time horizons (with species growth algorithms) for each subarea, including also information needed for establishing compensation payments for landowners. All the information can be accessed and updated through an APP for mobile devices, which includes navigational field tools. Examples are in Fig. 2.

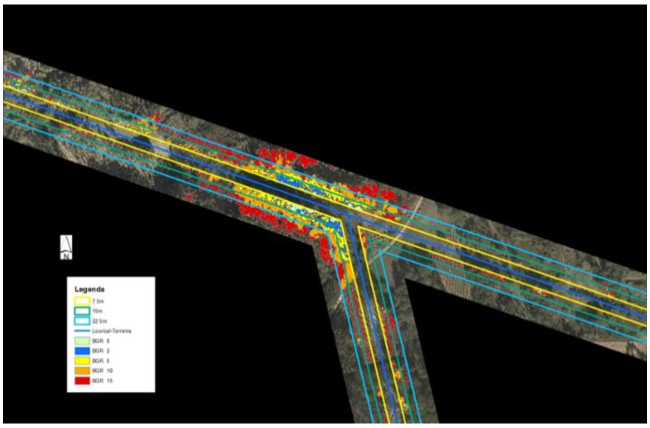

Fig. 2 Evolution of RMB in time horizon and risk parcels.

We select as reference the buffer of 30 meters (2x15 meters distance to the line (green polygon) with a 10 years horizon in order to find the balance between risk and investment. In Fig. 3 we show the risk function of the intervention by the line distance.

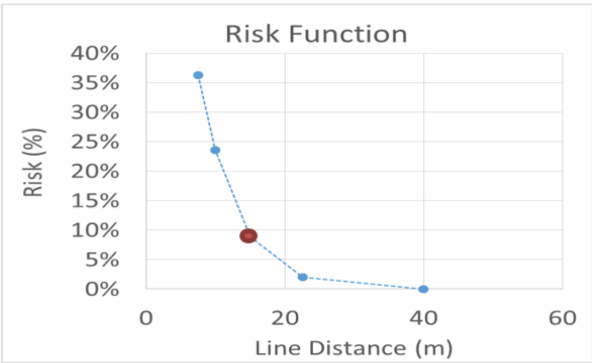

Fig. 3 Risk Function of line distance.

The risk of the channel, $risk_c$, was calculated by (1), where c is the channel length and the RMB_c is the area of risk management buffer of the channel c, and RMB_t is the total area of risk management buffer.

$$risk_c = 1 - \frac{RMB_c}{RMB_{total}} \qquad (1)$$

The risk function is hyperbolic, i.e., as the distance of the line, the risk decreases substantially. The 15 channel as a 9% of risk of falling in the line as shown in the red circle in Fig. 3.

In Fig. 4 we show the results of critical areas identified through advanced analysis performed with the data from LiDAR and HD camera (RGB/NIR) to record the forest features in terms of location, type and size of trees that may present a potential risk. We covered an area of about 3,900 ha (780 km x 2 x 40 m), in which 19% were safety corridors, where in the remaining 81%, only 7% represents risk to the line. We are intervening in about 4% of the total area covered by the LiDAR flights (without counting the area of safety corridors), and with only 4% of intervention we are able to reduce about 91% of the risk in those areas. Note that if we found constraints in safety corridors we carry out the interventions.

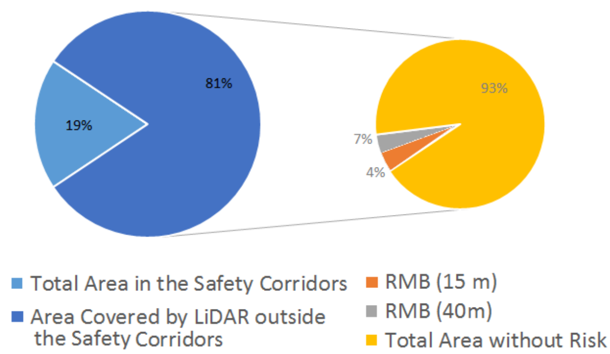

Fig. 4 Risk areas results under the LiDAR flights.

The identification and agreement with landowners have been the critical parts of this process. The first initiative towards assuring the process implementation was the promotion of awareness meetings with municipal and community councils, where most of the landowners were invited. We also had the support of environmental associations, namely forestry Technical offices as ICNF[2], as well as civil protection, GNR[3] and local and regional social media, among others, who helped us in this process. These sessions, together with the involvement of all of the

[1] SGIF- *Sistema de Gestão Integrado de Faixas* - Integrated Management System of Safety Corridors

[2]ICNF- *Instituto de Conservação da Natureza e da Floresta* -Forest and Nature Conservation Institute

[3] GNR- *Guarda Nacional Repúblicana* – Republican National Guard (local oversight identity)

stakeholders, guaranteed a successful dissemination of the concept with the community and with the landowners.
At that point, it was decided to carry out interventions on scattered land plots, which had trees presenting a risk to overhead lines with concentrated areas below 500 m^2. Despite scattered plots represented about 3% of the total risk area, they are owned by 40% of the total existing landowners. The contact with these landowners was established through a prior Communication Plan, in accordance with the process adopted by EDP Distribuição, which included on-site awareness meetings, information disclosure in the media, posted announcements in public places and individual letters for each of the landowners (when it was possible to obtain their address).
For the remaining 60% landowners, we conducted negotiations directly with the help of expert consultants in this area, formalizing the agreement with a standard document created. It was not possible to reach an agreement in all these situations, and alternative measures were taken to reduce the risk in these areas, such as:

- Installing underground cables as an alternative to overhead lines.
- The use of insulated overhead line conductors
- The use of aerial bundled conductors (ABC) on overhead lines.
- Change tracings.
- Strapping the trees.
- Others.

The negotiation was also committed to the fact that the value of the compensation is never below the value initially estimated, which is considered in the agreement document. After the agreement and the interventions, a loss report is carried out with the total value of the compensation, which may be higher than the estimation value if justified by the intervention.

The interventions at Louriçal were made in the base of promoting the replacement of fast grow tree species by other biodiversity valuable tree and shrub species and mitigating CO2 emissions through reforestation. In a region where eucalyptus and pines are dominant forest species, these RMB include the implementation of a strategy of controlling invasive plant species such as Acacia sp.
Acacia sp. was identified as being present in safety corridors. Due to its fast growth, it increases maintenance costs by up to 4 times the average cost. Furthermore, this species is considered a problem by environmental authorities. A control strategy for this species, associated with the RMB, was developed in order to maximise the environmental benefits associated with the RMB concept [5] and [6].

CONCLUSION

The results of this Pilot Project are being evaluated with a validation model of the RMB concept, which will allow to monitor and validate the positive evaluation of this concept with objective data, particularly with the interruptions number in this area manly due to EWE.
This methodology will be used in other areas identified as vulnerable to those events, more specifically to 43 municipals in continental Portugal.
The use of RMB concept to increase network resilience to extreme weather events is being used innovatively, protecting the biodiversity and guarantying that interventions are CO2 neutral, leading to ecological sustainable corridors.

REFERENCES

[1] Prata, R., Pereira, S., Vieira, M. e Verdelho, M.I., "Innovative solution of safety corridor design for overhead lines: Increasing resilience to extreme weather events while providing environmental benefits", 23rd International Conference on Electricity Distribution, Lyon, Jun. 2015.

[2] Prata, R., Pereira, S., Vieira, M. e Verdelho, M.I., "Innovative solution of safety corridor design for overhead lines: Increasing resilience to extreme weather events while providing environmental benefits – Concept Implementation", International Conference on Electricity Distribution Workshop, Helsinki, Jun. 2016.

[3] Miranda P., Turkman F., Viterbo P., Bermudez P., Lima D., Pereira P., Cardoso R., Mendes M., Turkman A., Chinita M. J., "*Estudo do Impacto Meteorológico sobre as Infraestruturas Eléctricas de Portugal Continental*", Instituto Dom Luiz – ULisboa, Centro de Estatística da ULisboa, Instituto Português do Mar e da Atmosfera (IPMA), Lisbon., Portugal., 2014.

[4] FloraSul, "*Projecto Piloto Do Louriçal*", Preliminary version, FloraSul, EDPD, Lisbon., Portugal, 2013.

[5] FloraSul, EDP Distribuição, "*Manual de Boas Práticas para Áreas Com Estatuto de Protecção Ambiental*", Lisbon., Portugal, 2011.

[6] FloraSul, EDP Distribuiçao "*Manual de Boas Práticas para Áreas Sem Estatuto de Protecção Ambiental*", Lisbon., Portugal, 2011.