Reference Note: Quick Guidance for Preventing Electrocution Impacts on Birds

Initiated by International Association for Falconry and Conservation of Birds of Prey

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Introduction

Low and medium voltage electric power distribution lines are a feature of almost all landscapes and can be constructed with different materials and in shapes and sizes. The use of electricity requires an effective distribution system between the centres of production and consumption via a dense network of power lines. New power lines are being developed at an increasing pace, due to growing energy demands, and existing lines are being modernized. If not designed safely, distribution lines result in devastating impacts on birds, especially those that are medium and large-bodied, such as raptors (or "birds of prey") – see Annex, and other wildlife species. Surprisingly, some "modernized" lines in certain countries (e.g., Mongolia or Morocco) are having a *higher negative impact,* due to dangerous configurations of pylons, especially those of metal or concrete with metal crossarms, which are more dangerous than some old traditional distribution power lines in some places where they were constructed with wood. There are over 65 million km of medium- and high-voltage power lines across the world, with this figure rising at a rate of 5% each year (Jenkins *et al*., 2010[1]). The impact of these linear infrastructures includes the death by collision and electrocution of millions of birds and other animals, such as monkeys and bats, as well as habitat degradation and fragmentation (see Martin-Martin *et al*., 2019[2]).

It goes without saying that underground distribution lines are 100 percent wildlife safe, since that is often not possible, this Reference Note ("Note") provides simple-to-use guidance on how to prevent electrocution impacting on birds. The guidance provided here is especially relevant for projects financed by International Financing Institutions that have included this topic in associated environmental guidelines[3]. This Note focuses nearly exclusively on distribution lines (6-66 kV) rather than on high-voltage transmission lines (> 66 kV) or low-voltage lines (110-400 V), which do not typically present an electrocution risk.

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Or: Sielicki J., et al, 2020. Quick Guidance for Preventing Electrocution Impacts on Birds, Reference note. International Association for Falconry and Conservation of Birds of Prey.

Available online at: www.birdelectrocution.org.

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[1] Jenkins, A.R., Smallie, J.J. & Diamond, M. 2010. 'Avian collisions with power lines: a global review of causes and mitigation with a South African perspective'. *Bird Conservation International* 20(3):263-278.

[2] Martín Martín, J., Barrios, V., Clavero Sousa, H. et Garrido López, J.R. 2019. *Les oiseaux et les réseaux électriques en Afrique du Nord. Guide pratique pour l'identification et la prévention des lignes électriques dangereuses*. UICN Gland, Suisse et Malaga, Espagne. xvi + 272 pp. doi.org/10.2305/IUCN.CH.2019.09.fr

[3] E.g., The World Bank Group's Environmental, Health, and Safety Guidelines for Electric Power Transmission and Distribution (April, 2007)

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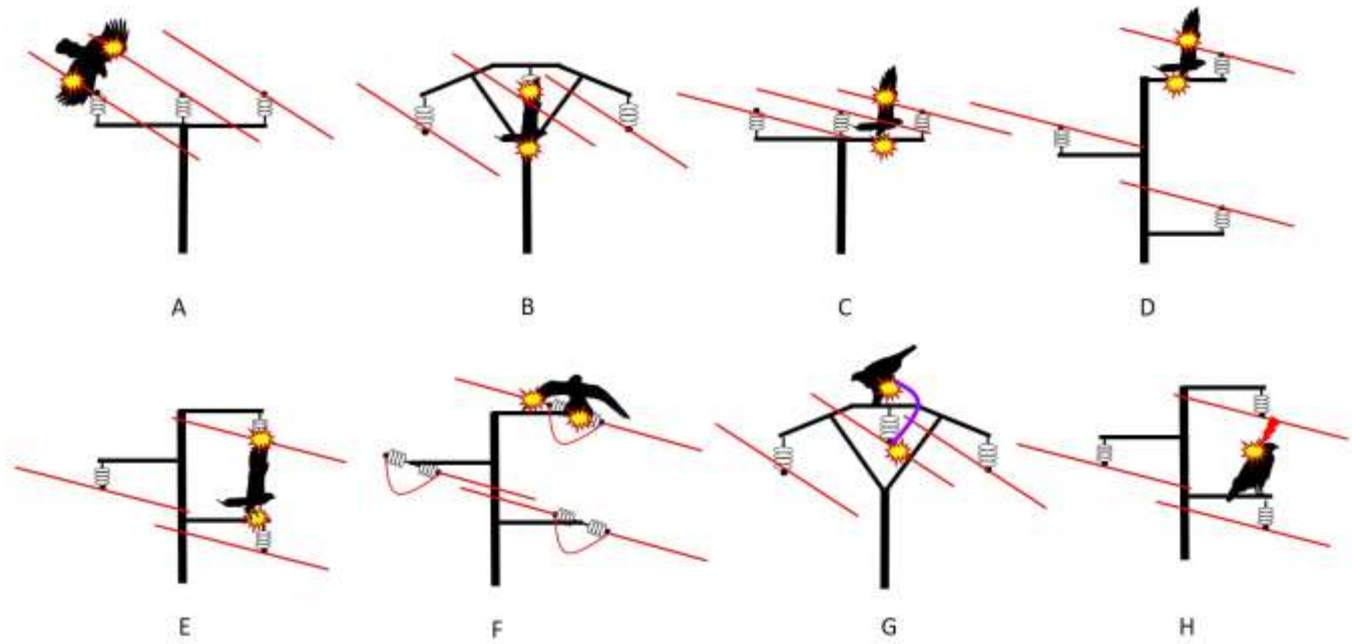
Background

Electrocution risk depends on three factors: i) structure and pylon configuration; ii) size of bird; and iii) landscape considerations. Nevertheless, the main causes of electrocution are related to the design of utility poles and associated equipment, and the construction materials with which they are made. Electrocution occurs when i) the body[4] ("wrist to wrist") of a bird touches the two conductors simultaneously (Figure A); or, ii) a conductor and a grounded component, i.e., the tower (Figures B, C, D, E, and F); and, more rarely iii) by defecation (Figure G) or by the formation of an electric arc (Figure H) under specific weather conditions[2]. Due to the effect of such different factors, electrocution does not occur randomly, but is concentrated in certain areas of a powerline. That said, birds can still safely perch on distribution lines, provided the correct design is in place.



Figures A-H: Different mechanisms of electrocution in power poles (from Martín Martín *et.al,.* 2019[2])

High risk landscapes

Electrocution risk is higher in some types of landscapes or conditions than in others. Where birds do not have many natural perches, they will take advantage of artificial perches. For example, distribution lines placed in open and flat landscapes, like deserts, steppe, grasslands, marshes, open agricultural landscapes, or on mountain ridgetops, rather than on slopes. Conditions such as prey concentration areas or landfills that may attract certain raptors will also increase risk.

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[4] As measured by the "wrist to wrist" distance or the distance from the tip of the bill to the tip of the tail.

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Relevant sectors

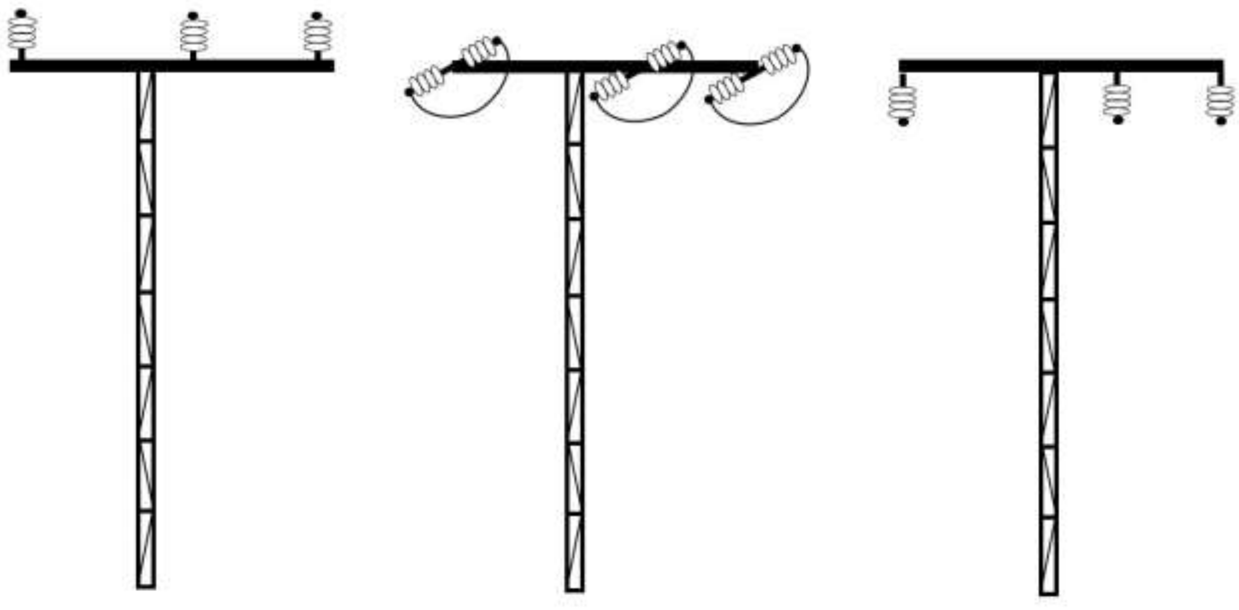
This guidance is applicable to the following sectors: utility companies (production and distribution), renewable energy developers (hydropower, wind and solar projects that may have aboveground distribution lines or "collector" lines), oil & gas / mining companies, railway and telecommunication.

Safe design options

Two main design factors make lines hazardous: 1) energized conductors separated by less than the wrist to wrist distance of a bird[5]; and, 2) the distance between grounded hardware (e.g., ground wires, metal braces) and an energized conductor that is also less than the wrist to wrist or the distance from the tip of the bill to the tip of the tail. While there are many types of designs for utility poles and their associated infrastructure, this Note outlines basic principles that apply to new or modernised powerlines. Again, these recommendations are made if burying the distribution lines is not possible.

While there are a number of mitigation options, the preferred one is to avoid risk, **ensuring that there is a safe design of the cross arm and its related equipment for new power lines**:

- Among the three types of insulators there are: "pin" insulators (Figure J), "deadend/strain" insulators (Figure K) or "suspended" insulators (Figure L). Pin insulators and deadend/strain insulators have the major electrocution risk, unless appropriate distances and measurements can be obtained, whilst L is much safer, as the conductors are always beneath the bird position, which is on the top of the cross arm. However, even with suspended insulator design, a safe distance should apply between the suspended conductor (or jumper wire, if it exists) and a lower branch in the cross arm (see Figure M, at the end of this document).



J K L

Figures J-L: Types of insulators (from Martín Martín *et.al*,. 2019[2])

[5] In wet climates, safe distance between energized parts should be based on wingspan and toe-to-wing tip distances of the largest perching species in the area since wet bird feathers provide less insulation.

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Other type of equipment with different configurations also have high electrocution risk, e.g., tap, transformer, derivation and switch poles. Although they are less frequently found in the powerlines, these aspects may concentrate higher numbers of electrocution cases (see example images 1 and 2 below).

Image 1: Examples dangerous equipment of the lines (photo J. Martin Martin & A. Camiña)

In pylons with deadend/strain insulators, the jumper wires must be fixed beneath both the conductors and the insulators instead of being over the cross arm. In addition, insulators must be installed complying with the minimum safe distances (see below).

Image 2: Example of proper design of strain insulators (it is the same configuration to deadend insulators) (photo J. Martin Martin & A. Camiña)

There should be a safe distance between the energized conductors or a wire and any grounded element of the pylon, including any suitable perching site under the jumper wires. This safe distance should be considered ***according to the largest species with occurrences in the region***. As a minimum it should be set to 100-150 cm.

- Lastly, not only the technical design of the distribution line itself, but also its network layout should be evaluated beforehand from the point of view of the impact on wildlife – by assessing the potential risks to birds and other species and the sensitivity of the areas that are going to be crossed by the infrastructure.

- If the above options are pursued, then the design will be considered safe for birds.

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Mitigation options

- If suspended insulators and the other design recommendations are not possible, then mitigation options should be applied to the different parts of the cross arm. There is a variety of retrofitting solutions in the market that easily adapt to each specific electrocution problem such as insulator caps or conductor covers.

- If insulation is pursued, the insulators must be made of a durable material (e.g. resistant to cold/heat and UV). Otherwise, they may soon lose their effectiveness. For example, rubber, which is used to insulate wires through retrofitting, may begin to disintegrate in environments with excessive heat. Qualified technicians are also required for their installation. These materials and devices should be also monitored over time and, when necessary replaced, as they are not always a permanent solution.

- In the configurations with high electrocution risk (derivations, tap, transformer and switch poles and its connected grounded wires and jumpers) all grounded elements should be insulated, and grounded wires and jumpers should be sheathed wires.

- Sheathed wires should be always used in wooded areas with tree mammals potentially impacted (monkeys, squirrels, large bats, etc,).

- In metal cross arms with top pin insulators the use of extended centre pins avoids electrocution for small birds only, but is very dangerous for larger ones, such as falcons, eagles or vultures (see image below). The insulation of the conductors or of the crossarm and exclusion of possibility to sit on the top of the pylon are the safest approach. (Dixon *et al* 2019[6])

Image 3,4: Pylon with centre top pins and dead Saker, Mongolia (photo: A. Dixon) and retrofitted, safe for birds (photo O. Dorjsuren)

- Due to the great diversity of utility companies worldwide, the materials, designs of distribution lines, specific country requirements, and species and habitats involved, a careful shared environmental and technical cooperation is strongly recommended at the early planning stage of any project.

[6] Dixon A,. et al, 2019, Mitigation_Techniques_to_Reduce_Avian_Electrocution_Rates, *Wildlife Society Bulletin* 43(3):476–483; 2019; DOI: 10.1002/wsb.990

The use of perch deterrents to avoid birds perch close to grounded elements is less effective than safe designs of cross arms and insulation works. If perch deterrents are the only alternative, on account of costs or cross arm design, their design and placement must be then carefully considered taking into account the sensitive species present.

Distances between components

- Recommended distances to make pylons safe for birds either with suspended (images shown below on the left-hand side) or strain insulators are shown in Figure M. Note that pylons with pin insulators are rarely safe, even with insulation, given long-term maintenance needs. Distances in Figure M are provided are in meters (Government of Spain 2008[7], Ministerio para la Transición Ecológica 2018[8]). Color-coding on Figure M is as follows
    - Red: Energized conductors or jumper wires
    - Black: powerline insulators (vertical-suspended, horizontal-strain)
    - Green: areas in the cross arm that need from further mitigation for conductors and jumper wires. In the case of the powerline insulators, these are the minimal lengths they should have.
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[7] Government of Spain. 2008. Real Decreto 1432/2008, de 29 de agosto, por el que se establecen medidas para la protección de la avifauna contra la colisión y la electrocución en líneas eléctricas de alta tensión. (*Royal Decree 1432/2008, 28th August. Measures to protect bird species against electrocution and collision at power lines*). https://www.miteco.gob.es/es/biodiversidad/temas/conservacion-de-especies/especies-silvestres/tendidos/ce-silvestres-tendidos.aspx

[8] Ministerio para la Transición Ecológica. 2018. *Recomendaciones técnicas para la corrección de los apoyos eléctricos del riesgo de electrocución de aves, para la adaptación de las líneas eléctricas al R.D. 1432/2008*. Goverment of Spain.

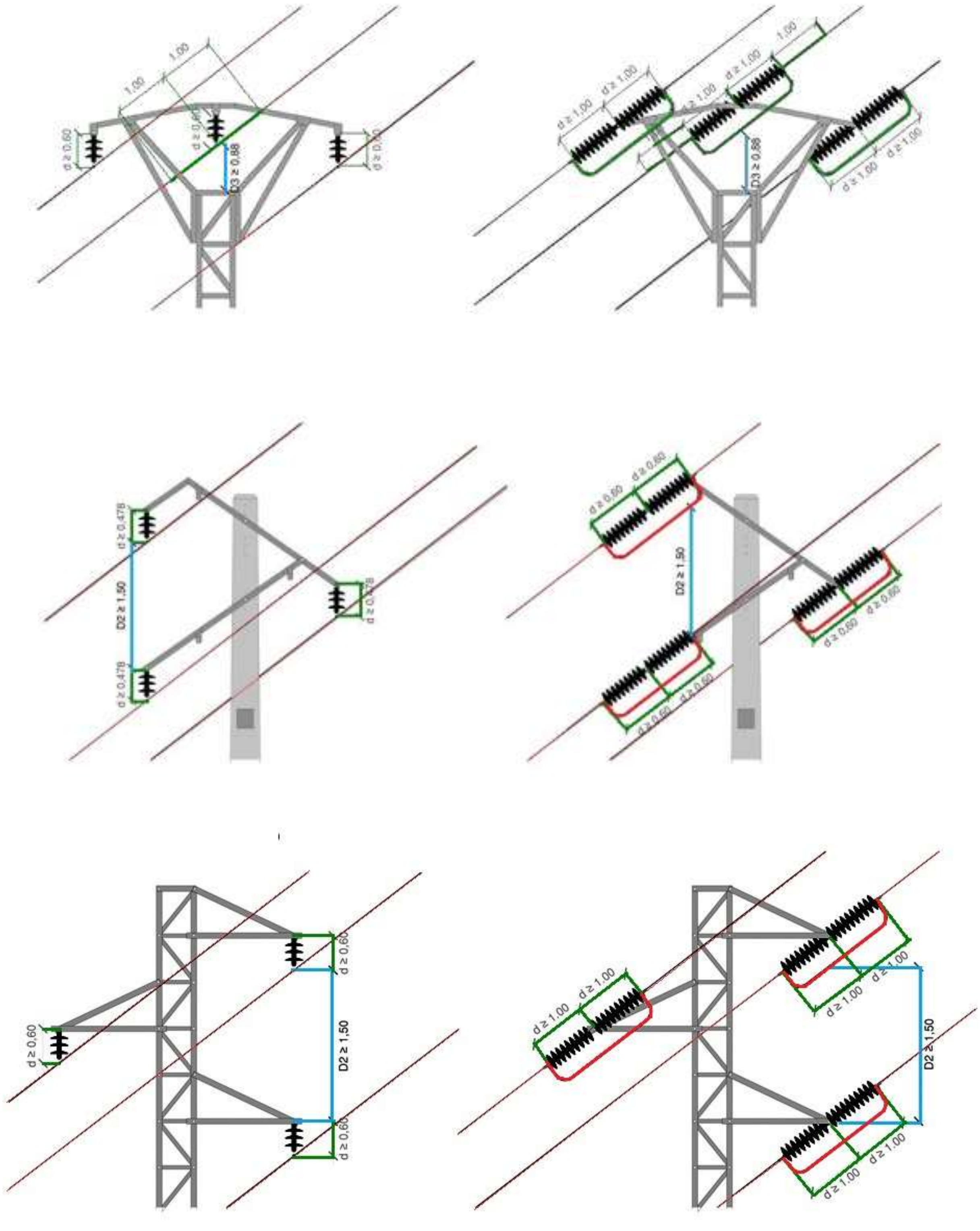

Figure M. Recommended distances to make pylons safe for birds (Government of Spain 2008[7] , Ministerio para la Transición Ecológica 2018[8]).

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ANNEX

Severity of impacts on bird populations, mortality from electrocution with power lines for different families of birds in the Western Palearctic.

0 = there are no reported or likely casualties; I = reported deaths, but no apparent threat to the bird population of this family; II = high regional or local losses, but without significant impact on the overall conservation status of the species; III = the victims are an important factor of mortality, threatening an endangered species, at regional level or on a larger scale. Sources: Prinsen *et al.*, 2011[9]; Derouaux *et al.*, 2012[10].

Specie's group	**Severity of the impacts by electrocutions**
Storks (Ciconidae)	III
Raptors: vultures, eagles, falcons (Accipitriformes and Falconiformes)	II – III
Owls (Strigiformes)	II - III
Raven, Crows and Magpies (Corvidae)	II
Pigeons and Doves (Columbidae)	I-II
Rollers (Coraciidae) and Parrots (Psittadidae)	I-II
Cormorants (Phalacrocoracidae)	I
Herons and Bitterns (Ardeidae)	I
Hoopoes (Upupidae) and Kingfishers (Alcedinidae)	I
Ibises (Threskiornithidae)	I
Pelicans (Pelicanidae)	I
Plovers, lapwings and Curlews (Charadriidae et Scolopacidae)	I
Skuas (Sterkorariidae) and Gulls (Laridae)	I
Small and medium-size songbirds (Passeriformes)	I
Woodpeckers (Picidae)	I
Bee eaters (Meropidae)	0 – I
Terns (Sternidae)	0 – I
Bustards (Otidae)	0
Coots, Moorhens and Crakes (Rallidae)	0
Cranes (Gruidae)	0
Cuckoos (Cuculidae)	0
Ducks, Gooses, Swans (Anatidae)	0
Flamingos (Phoenicopteridae)	0
Gannets (Sulidae)	0
Grouses (Pteroclididae)	0
Nightjars (Caprimulgidae) and Swifts (Apodidae)	0
Partridges, quails and Grouses (Galliformes)	0
Penguins and Guillemots (Alcidae)	0
Plongeons (Gaviidae) and Grebes (Podicipedidae)	0
Puffins and Petrels (Procellariidae)	0

[9] Prinsen, H.A.M., Boere, G.C., Píres, N. & Smallie, J.J. 2011: Review of the conflict between migratory birds and electricity power grids in the African-Eurasian region. CMS Technical Series No. XX, AEWA Technical Series NO. XX, Bonn, Germany.

[10] Derouaux, A., Everaert, J., Brackx, N., Driessens, G., Martin Gìl, A. & Paquet, J.-Y. 2012. *Reducing bird mortality caused by high- and very-high voltage power lines in Belgium*, Final report. Elia and Aves-Natagora