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GUIDELINES FOR BEST PRACTICE ON MITIGATING IMPACTS OF INFRASTRUCTURE DEVELOPMENT AND AFFORESTATION ON THE GREAT BUSTARD

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Birdlife International
European Division

Guidelines for best practice on mitigating impacts of infrastructure development and afforestation on the Great Bustard

Prepared for the Memorandum of Understanding on the conservation and management of the Middle-European population of the Great Bustard under the Convention on Migratory species (CMS) by

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1. Introduction

The Great Bustard is a globally threatened species, which has suffered rapid population decline during the 20th century (Collar & Andrew 1988, Collar et al. 1994, BirdLife International 2000, 2004, 2008). To address the conservation of the species, a European Action Plan has been prepared (Kollar 1996) and endorsed by the Steering Committee of the Bern Convention and the Ornis Committee of the European Union. In 2001, a Memorandum of Understanding on the Conservation and Management of the Middle-European Population of the Great Bustard (MoU) was concluded under the auspices of the Convention of Migratory Species (CMS).

The Medium Term International Work Programme 2005-2010 (MTWIP) identifies issues for which guidelines should be developed. The first of these guidelines was produced on capturing and handling birds for research (Alonso 2008). The second guideline was produced on monitoring Great Bustard populations (Raab et al. 2009) and the present document contains the third guideline, which consist of a review of existing experiences of the impacts of infrastructure development and afforestation on the Great Bustard.

The MoU Action Plan (CMS 2000) defines the most important conservation measures to be carried out by all Range States in order to achieve the recovery of the species. The relevant tasks to the infrastructure development and the afforestation are in the Box 1 (The numbering is equal to the one of the Action Plan).

Box 1: Relevant MoU Action Plan tasks to recent guideline.

1. Habitat protection

It is essential that key habitats of the Great Bustard be maintained and, where appropriate, restored by means of protected areas and/or otherwise.

1.1 Protected areas

1.1.1 Legislative measures

The responsible authorities should provide the species with full legal protection throughout its range to ensure that key habitats will be maintained. Inter alia, protected areas for the Great Bustard should include the entire range of semi-natural habitat, such as partly-cultivated land, steppes, semi-steppes and grasslands, in which the movement of juveniles and adults during dispersal occurs. [1.1.3]

Degraded areas which are essential for the reestablishment of Great Bustard populations or for the maintenance of viable populations should also be put under legal protection, as far as appropriate and feasible, in order to restore them.

1.3 Prevention of fragmentation or isolation of the Great Bustard's habitat [1.1.2, 2.2.2]

1.3.1 Afforestation [1.1.2]

Afforestation projects should be subject to an assessment of their effects on the Great Bustard's habitats taking into account the damage to the Great Bustard which may be caused through the fragmentation of extensive farming habitats. Afforestation should be prevented in Great Bustard areas.

1.3.2 Other activities resulting in habitat fragmentation [2.2.2]

The construction of new roads or highways and railways, the planting of shelter belts and irrigation should be avoided as far as possible in Great Bustard areas. All these and other infrastructure measures should be subject to environmental impact assessments which should consider viable alternatives and take into account the special sensitivity of the Great Bustard to disturbance and habitat encroachment. Fences should either be avoided or constructed in a way that permits the free movement of chicks.

2. Prevention of hunting, disturbance and other threats

The Great Bustards should be protected from hunting, any disturbance and other threats. [1.1.6]

2.2 Prevention of disturbance

Any disturbance of Great Bustards should generally be kept low. Necessary interventions into areas where Great Bustards occur should be the least disturbing for the birds.

Disturbance should be prevented at the breeding and display sites of the Great Bustard. Appropriate means to restrict or control access to breeding sites should be developed and their use encouraged.

Immediate action should be taken to manage those breeding sites where females regularly fail to raise their young as a result of agricultural activities or other disturbances. In areas of high Great Bustard density, temporary protection schemes should be put in place and enforced to ensure appropriate breeding conditions.

2.3 Other threats to the Great Bustard

2.3.2 Adoption of measures for power lines [2.2.3]

Existing lines which cross Great Bustard areas should be buried or marked prominently. New lines should not be built across Great Bustard areas.

2.3.3 Compensatory measures

Any activities which will create new loss or degradation of Great Bustard habitat or longer term disturbance of the species should be compensated by appropriate measures.

Numbers in brackets provide cross-reference to the European Great Bustard Species Action Plan (Kollar 1996)

2. Vulnerability of Great Bustard to infrastructure and afforestation as a result of species-specific characteristics

2.1. Habitat use and area fidelity of Great Bustard

The Great Bustard originates in steppe areas. After the deforestation during the medieval, it became a common bird in the open landscapes of Europe. Thus the optimum habitat for Great Bustard in Central Europe is the open, unfragmented and extensively managed agricultural land with high proportion of fallow land, which is supported by special set-aside schemes.

The Great Bustard shows a unique displaying behaviour. In a matter of seconds displaying males transform themselves from steppe-coloured birds into almost entirely white "feathers balls" by turning around their plumage in such a way that the white undercoverts and the white undersides of primary and secondary flight feathers face upwards. The normally well-camouflaged males thus become highly conspicuous, and they attract females over great distances by trampling and turning around slowly (Snow & Perrins 1998).

At the early stage of the Great Bustard studies, it was only known that there are traditional displaying, breeding and wintering sites everywhere in the distribution area. With the help of radio-telemetry, it could be proven that both females and males show a high degree of fidelity to their lek and breeding sites. In Spain, 25 out of 27 adult females (93%) attended the same lek over several years. 21 out of 24 (88%) showed fidelity to nesting area. (Alonso et al. 2000). Also in Spain, all males showed inter-annual fidelity to their lek sites (6 ind.) and all (4 ind.) also showed fidelity to their postbreeding areas (Alonso et al. 2001).

This fidelity is so strong, that if a traditional site became unsuitable for Great Bustards, the native individuals keep going back for years and even some females may try to breed there without success. Thus the depopulation of the site only happens years after its destruction. Habitat selection and genetic studies suggest limited colonization capacity due to the strong site fidelity (Lane et al. 2001, Martín et al. 2002). This implicates that habitat loss is almost irreversible.

2.2. The characteristics of the Great Bustard's flight

The Great Bustard is the heaviest flying bird of Europe. Great Bustards regularly fly either locally or over larger distances because of disturbance, seasonal change of habitat preferences, occasional visits to previously inhabited sites, flights between different subpopulations, dispersion and facultative migration on harsh winters. When flushed, Great Bustards either fly off in large loops and then return to the point of departure in several minutes or they fly over longer distances to a different site. In exceptionally severe winters bustards are liable to be displaced over several hundreds of kilometres.

Great Bustards can take off from the spot with powerful wing beats, but normally they take flight slowly and clumsily. While they are tireless fliers and can cover distances of more than 300 km per day (Watzke, 2007), their manoeuvrability is limited by their great weight and large wingspan.

The vulnerability of Great Bustard to power lines arises from the characteristics of the species. Because of lifting and holding its weight cost a lot of energy, it typically spends most of its time on the ground. Usually, they fly maximum 1-2 km at low height (maximum a few tens of meters). Their flight is powerful. They can reach speed of 50-60 km/h, but in backwind even100 km/h.

Some observer also reports some Great Bustard movements during night (Gewalt, 1959), but basically it flies in dark only when disturbed, but do not migrate at night.

2.3. The shyness of Great Bustard

Great Bustards are watchful and wary. When disturbed, both displaying and breeding birds as well as females with young, may fly over 1 km distances.

3. The main infrastructural elements and the afforestation and their possible effects on Great Bustard

3.1. Power lines and similar obstructions

Wire fences, electric fences, overhead cables of electrified railways, telephone cables impose a similar risk to power lines. Clearly, electric power lines are the most widespread of all. E.g. there are approx. 58 000 km above-ground medium voltage power lines in the 93 000 km² area of Hungary (Horváth et al. 2008). However, other aerial cables (for example overhead contact lines) can pose a greater threat to Great Bustards in some areas (MoU Hungarian National Report, 2008).

3.1.1. Collision to power lines

Aerial cables pose a threat to Great Bustard, because the bird can collide with the horizontal wires stretched at different altitudes during their powerful and straight flight. Although they can even suffer electric shock when they hit the lines, they do not die from the electrocution, but from collision. The electrocution, which cause the death of millions of birds worldwide (Kjetil Bevanger 1998) does not occur with Great Bustards because they never land on poles. Aerial cables in the altitude of 1 to 10 m (i.e. from electric fences to the middle voltage power lines) impose a threat because Great Bustard hit them when flying short distances. However, wires above 10 m, e. g. high voltage lines, endanger them while they fly long distances (a few kilometres or more).

Collisions with overhead power lines are currently the most significant mortality factor for fully grown (i.e. immature and adult) Great Bustards in a number of countries. Once in the Westliches Weinviertel site, in Austria, 4 Great Bustard males collided to a high voltage electric wire at the same time, and just here, minimum 14 individuals (74 % of the known casualties) died from this type of collision between June, 2001 and May, 2008, while the size of this subpopulation was only about 50-60 birds in this period (Raab, unpublished).

In Portugal, yearly almost 7% (92 individuals) of the national Great Bustard population collide with power lines, according to two studies (Neves et al. 2005, Infante et al. 2005). In the Madrid province, in Spain the determined mortality rate of Great Bustards is about 3 % for juvenile males, 2 % for juvenile females, and moreover the same values for adult birds are 6 % and 3 % (Martín et al. 2004).

3.1.2. Circumstances influencing the collision risk

According to the experiences, this pitiable accident occur in glaring sunshine (at sunset or sunrise), and in foggy weather more often (Bevanger 1994, Dorin 2005). The altering effects of topography is also proven in case of other bird species (Bevanger 1990), and we can agree the similarity to Great Bustard, for example a power line in the hiding of a shelterbelt is less dangerous than another in open landscape.

The constructions of the power lines have an affect in the probability of collisions. The multi-level arrangement of the cables multiplies the height of the impassable belt in the air. The thickness and the colour of the wires moderate their visibility, too.

The density of the Great Bustard population and the flying activity of the birds basically determine the number of the crossing movements, the denser population and the presence of power lines in Great Bustard flight route result higher probability.

The number of Great Bustard carcasses found always represents a minimum number and do not truly quantifies the problem. If the birds crash at high speed into cables, the collision can cause instant death. Even if the bird survives the collision, serious injuries, such as fractured bones of the extremities or the vertebra and skull, skin and muscle injuries, usually cause death secondarily. Several studies reveal high scavenger activity (e. g. Slater 2002), which can also lead to underestimation.

3.1.3. Reduction of availability of areas for birds

Sometimes Great Bustard can be seen close to or under power lines, but it is proven in studies, e. g. Lane et al. (2001), that the total observation of Great Bustard flocks were significantly higher further from power lines than control points. This means that power lines also cause loss and fragmentation of the habitat used by the population in addition to the potential direct mortality. The habitat fragmentation and barrier effect is presumably more pronounced when the wires are erected parallel to another linear infrastructural landscape element, due to the cumulative effects (Bélisle & St. Clair 2001).

3.2. Wind farms

3.2.1. Impacts of wind farms

Apart from direct habitat loss, which is mostly minor, some species may experience an indirect loss or deterioration of habitat. This might be caused by an increase in disturbance from the wind farm itself or from human activity, or be land-use changes. All may cause Great Bustards to abandon the area but quantification of the effects of wind farms can be confounded by these other changes. The complex interactions between bird populations are depicted in Figure 1.

Disturbance related to wind farms can be more critical to some species than the direct impact of collision. Disturbance can lead to displacement and exclusion from areas of suitable habitat; effectively loss of habitat to the birds. The scale of such habitat loss will influence the impact. There are a lot of reliable studies indicating negative effects, some reviews collected the main outcomes, e. g. Erickson et al. (2001), Gill et al. (1996), Horch & Keller (2005). The cumulative effects of large wind farm may lead to disruption of ecological links between feeding, breeding and roosting areas (Cooper & Sheate 2002).

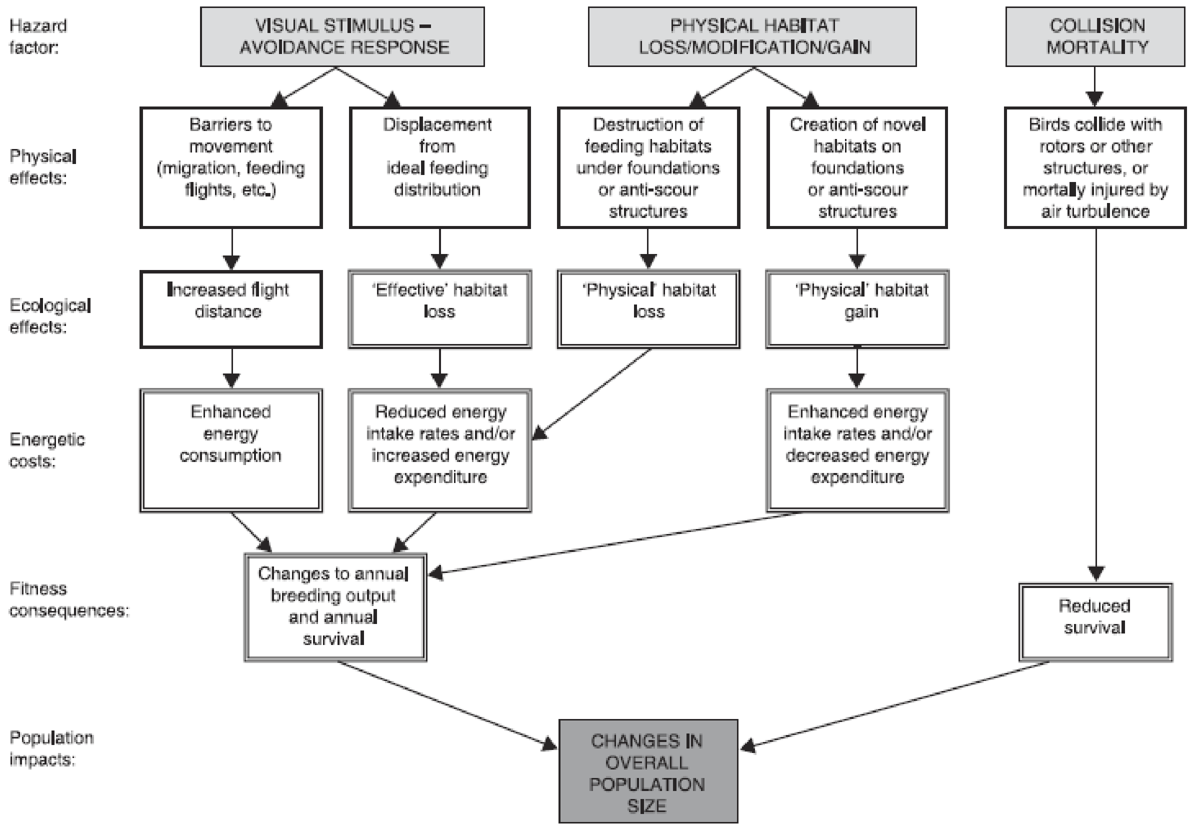

Figure 1. Flow chart describing the three major hazard factors presented to birds by the construction of wind farms, showing their physical and ecological effects on birds, the energetic costs and fitness consequences of these effects, and their ultimate impacts on the population level. (Source: Fox et al. 2006) This figure has been developed for off-shore wind farms, but it can be easily adapted for terrestrial wind farms locations.

In addition, wind power plants always require installation electric power lines, which introduce serious risk itself (see chapter 3.1.). Thus cumulative impacts of various factors shall be considered.

In case of Great Bustard, collision with the rotor is an insignificant risk, because the species rarely fly at that altitude. Until now, there is no verified case of Great Bustard being killed by wind turbines.

Habitat loss and fragmentation caused by the wind farm development impose a higher threat to Great Bustard than direct mortality because its high fidelity to its leks, breeding and wintering sites. Hence, a wrongly planned wind power plant can destroy very important habitats. Up to now, there is only one study available from Hans Wurm and Hans Peter Kollar (2002). This reveals that a wind power plant in Parndorfer-Platte, Austria has occupied a part of the Great Bustard habitat. In addition, the Great Bustards keep a distance of 600 meters from the wind towers.

3.2.2. The relevance of the wind farms

There is an increasing pressure to establish wind farms in Great Bustard areas because the conditions are highly suitable for generating wind energy and production of renewable energy is supported. For several years, wind farm development projects have caused most of the conflicts between nature conservation and infrastructure development in both Hungarian and Austrian side of the West-Pannonian Great Bustard areas or in Brandenburg, Germany

(MoU German and Austrian National Report 2008). It is likely that this pressure will affect many other sites as well in the near future.

3.3. Transport infrastructure

3.3.1. Impact of transport infrastructure on birds

According to our experiences of the West-Pannonian Great Bustard population it looks like there is an existing influence of transport infrastructure on the habitat use of the Great Bustard, but the influence is not quantified yet. So the results of studies on other bird species are more informative at the moment.

Most empirical data on the effects of infrastructure on wildlife refers to primary effects of a single road or railroad, which are easy to measure and affect the organisms directly at a local scale. Five major categories of primary ecological effects can be distinguished (Seiler 2001):

1. Habitat loss: Construction of roads and railroads always implies loss of habitat. Since every Great Bustard habitat is affected by road constructions, this is an extant problem across the European range of the species. The most threatened sites are those where the habitat is in suburban area, such the habitat of the German population close to Berlin or of the West-Pannonian one near to Bratislava and Vienna, or in the Northern Kiskunság near to Budapest. Although grassy field tracks or even dirt roads can be used for some activities by Great Bustards such as dust bath, roosting or feeding. However, the physical encroachment increases the disturbance and barrier effects that contribute to the overall habitat fragmentation effect of the infrastructure.

2. Disturbance: Roads, railroads and traffic disturb and pollute the physical, chemical and biological environment and consequently alter habitat suitability for many species in a much wider area than they actually occupy. However very little is known about the mechanism how disturbance could cause reduced densities of breeding birds. On the other hand, it is known that density is not always a good indicator of habitat quality and might even be misleading. As a consequence, species that did not show an effect on the density still might be affected by traffic. (Reijnen et al. 1997). For example based on the traffic noise effect an estimated 10–20% road-effect zones cover Netherlands, while roads and roadsides cover about only 1-2 % (Reijnen et al. 1996). Although the impact of transport infrastructure on Great Bustard has studied only tangentially, some publications prove the avoidance behaviour of Great Bustards from these landscape features (Lane et al. 2001, Osborne et al. 2001). Sometimes they breed close to roads, but there was not any reliable study on its breeding success, which can be less successful, similar to some evidence of other bird species studies (e. g. Reijnen, 1997).

3. Corridor: Although road verges and roadsides can however provide refuges, new habitats or serve as movement corridors for wildlife, to our knowledge, this is hardly relevant for Great Bustards.

4. Mortality: Traffic causes the death of many birds that utilise verge habitats or try to cross the road or railroad. Collisions between vehicles and wildlife are also an important traffic safety issue. Although the numbers of road victims can be rather large it was assumed that they are, in general, not sufficient to cause a significant increase of the total mortality of species (Reijnen et al. 1997). The Great Bustard strike is fortunately rather rare, due to their strict avoidance attitude, and this kind of accident occurs only occasionally (Raab, unpubl.).

5. Barrier: For most non-flying terrestrial animals, infrastructure implies movement barriers that restrict the animals’ range, make habitats inaccessible and can finally lead to an isolation of populations, for most of the birds, this barrier effect is not so strictly expressed. Compared to the other birds, however the Great Bustard suffer much more, due to their 'poor' ability for fly. Field observations attest that a busy highway with its effect-zone can be too big obstacle, and the flying birds turn back just before the highway (pers. obs.).

6. Cumulative effects: habitat fragmentation: we should also consider possible risks of cumulation of effects. Breeding birds suffer from many other environmental influences, of which the habitat fragmentations are considered one of the greatest importances. If the population size becomes very small there will be an increased risk of extinction due to demographic chance processes. Considering the extreme cautiousness of the Great Bustard, this cumulation supposedly has the biggest role in their habitat use, the abandonment of several fragmented habitats (Lane et al. 2001, Osborne et al. 2001).

Table 1: The relative importance of different primary effects in relation to the type of infrastructure and the spatial scale (opposing single infrastructure links and entire networks). The order of effects in the boxes suggests the relative rank in the importance of the effects for birds (Source: Seiler 2001).

Infrastructure type / Scale	Primary roads	Secondary roads	Tertiary roads	Railraods
Broad scale / Network level	Barrier / Isolation Mortality Disturbance	Barrier / Isolation Mortality	Corridor	Fragmentation Corridor Mortality
Local scale / Single infrastructure link	Habitat loss Barrier Disturbance Mortality	Mortality Habitat loss Barrier Disturbance	Corridor Habitat loss	Mortality Corridor Disturbance Habitat loss

3.3.2. The relevance of the roads

Nearly all Great Bustard areas have been fragmented by roads within the last century. The development of roads is still a problem: on the one hand existing roads are broadened or existing dirt roads are asphalted and new ring roads are established, in urban as well as in rural areas. Only some Great Bustard areas have been fragmented by highways within the last century. However, pressure on Great Bustard areas imposed by highways will rise in the next decades due to increased traffic. The Trans-European Transport Network (TEN-T) is the European Union's Transport Infrastructure Framework. This was initially adopted in 1990 and now includes Priority Projects on 30 international axes plus wider transport projects. By 2020 it is envisaged that the TEN-T will include 89500 km of roads and 94000 km of railways. One part of the TEN-T, the A2 motorway in Portugal has already damaged Great Bustard habitat in Castro Verde SPA (Byron & Arnold, 2008). Especially problematic is the fact that highways are used to build as far as possible from settlements which means that they are planned straight through the open landscape, sometimes in Great Bustard area.

3.4. Other infrastructural development

In addition to the power lines, the wind farms and the transportation many other infrastructural development endanger Great Bustard and its habitat. We discuss them together in a gathered chapter, seeing that they have probably less role – but locally with high relevance by chance, - and their impacts on birds are similar in general. These among others are the expansion of suburbs, hypermarkets and shopping centres, industry zones, the building of airports, entertainment grounds, leisure parks, photovoltaic fields, aboveground mines, etc.

3.4.1. Threat posed by other infrastructural development

1. Habitat loss is the main threat raised by these infrastructural developments with the common character of great superficial expansion. The changed habitat is not suitable for Great Bustard evidently, the damage can extend to entire habitats and the process usually irreversible.

2. Disturbance: the dismal spectacle, the noise, the chemical pollution and the human activity at infrastructures express the negative impacts by hundreds of ways, similarly to the roads, For example Devictor et al. (2007) found that urbanization induced community homogenization and that populations of specialist species became increasingly unstable with increasing urbanization of the landscape.

3. Direct mortality caused by the discussed infrastructures is not typical, but possible. A Great Bustard was hit by an airbus in Germany just a few years ago.

4. Barrier, habitat fragmentation: this is less typical to the infrastructures with two dimensional superficial expansions than to linear infrastructure elements, such as roads or power lines, but can be significant pending on the range, the location and the shape of them.

5. Cumulative effects: similar to the written at the transportation infrastructure chapter (3. 3.)

3.4.2. The relevance of other infrastructural development

The development of airports is a problem for Great Bustard areas not only in the surrounding of big cities (e.g. Berlin, Vienna, Bratislava, Budapest), but occasionally in rural areas, too, where airports are built for low cost airlines. Just in the last years the development of industrial estates and shopping centres took place in rural areas. In nearly every bigger village you can find this "new" kind of infrastructure. Besides this development another pressure comes from leisure parks and golf courses. This current problem is a new threat to Great Bustard areas and will be of greater importance in future. Only a few Great Bustard areas have been destroyed by gravel mines within the last century, but some Great Bustard areas are still threatened by the establishment of new gravel mines.

3.5. Afforestations, shelter belts, orchards, vineyards

Evidence for an effect of afforestations, shelter belts, orchards, vineyards on Great Bustard is anecdotal, it is generally assumed that the presence of woody areas affects the distribution negatively. In the scientific researches (e. g. Faragó & Kalmár, 2006, 2007, 2008, Lane et al. 2001) these habitat is ranged to minor or 'other' crops. In contrary in Spain droppings were often packed with olive stones (Lane et al. 2001) which prove the presence of Great Bustard in olive plantation, furthermore mostly in canicular days or in chilly wind they sometimes crouch in the shadow of tree lines and shelterbelts (pers. obs.), but these observations are exceptions to the rule.

The avoidance of Great Bustard to woody habitats is evidence, but the analysis of the effects on distributions should be straightforward with any accurate vector data source, similarly to the suggestion for roads and building by Osborne et al. (2001).

The habitat loss caused by afforestation and fragmentation by shelter belt plantations was surely catastrophic for example to the population in Hanság, Hungary, whereby the habitat totally damaged (Faragó 1979), and this changes in habitat can be a recent problem at many site all over Europe.

4. Best practice

The prevention would be always the best practice for nature conservation. This requires the knowledge of the natural values in the present case the distribution range of Great Bustard, and the potential endangering infrastructures. Designated protected areas in the Great Bustard habitats provide the convenient base for this purpose, and satisfactory rules of law can help this process. Very important to plan and assess the infrastructural developments previously, whereas the costs of the posterior measurements are usually higher and the damages are often irremediable, although sometimes necessary.

4.1. Mapping the conflict areas

The mission of spatial planning is to find adequate locations for all required activities and functions in the landscape. Spatial planning has the potential to minimize impacts on natural habitats, but requires good ecological data and adequate interpretation aiming to identify ecologically significant ecosystems and incorporate their conservation or appropriate management into spatial plans in order to minimise conflicts (see: Guidelines for monitoring of population parameters of Great Bustard and of the effects of management measures (Raab et al. 2009)).

An appropriate example is the study what was carried out by the BirdLife Hungary (Horváth et al. 2008) on the evaluating the Hungarian medium voltage power line network from the bird protection point of view. The map in the figure 2 is a result of an overlay of importance of areas for certain species (Great Bustard, Common Crane, Geese and Storks) and the distribution of the medium voltage power lines.

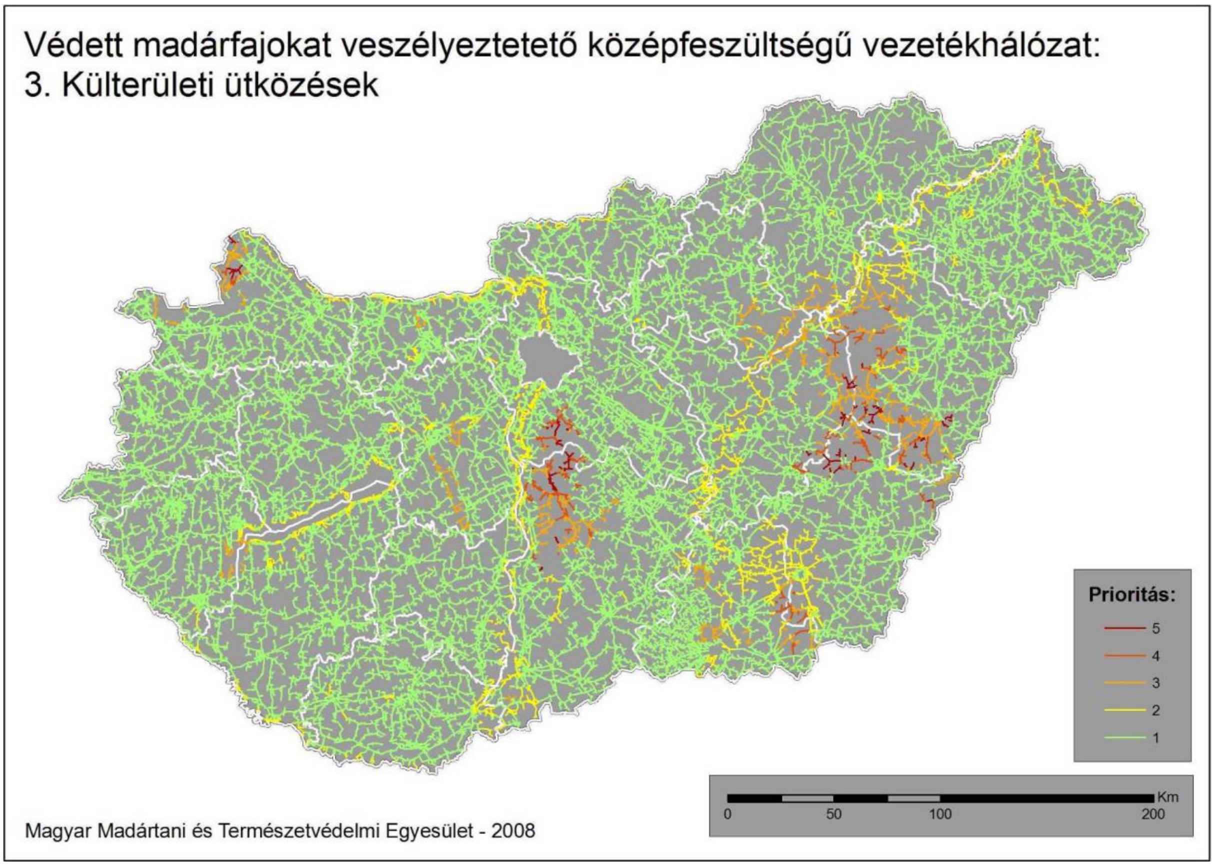

Figure 2: Map of medium voltage power lines in the outskirts of Hungary endangering birds by collision (source: Horváth et al. 2008). Priority from high (5) to low (1).

4.2. Designation of protected areas

Every government over the distribution range protects the Great Bustard species by national laws and international conventions, and articles are having effect also on its habitat, theoretically even outside designated areas. But practically the protection measurements and the restrictions can be more easily enforced in protected areas, and moreover most of the financial funds necessitate designated protected areas for subsidy.

By consequent monitoring the Great Bustard habitat can be mapped, and the designation of the main used habitats to protection is an essential expectation. The designations in several countries are already done for example to national parks or Special Protected Areas (SPA) or Important Bird Areas (IBA) or other satisfyingly, but the designations should be revised from time to time.

4.3. Satisfactory legislation background

For the interest of the coexistence of the successful nature conservation and the sustainable development, the legislation has to be extended to the binding preparation of Strategic Environmental Assessments and Environmental Impact Assessments for every significant infrastructural development. Over and above it the laws have to order the usage of mitigation practices, Great Bustard-friend standards in as many spheres of life as possible.

Ensuring a high level of protection of the environment and to contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development, environmental assessment should be carried out in accordance with the EU Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment.

4.4. Strategic Environmental Assessment

The problem is that investors, decision makers, leaders have no information about the ecological values in the sphere of their authority, and the possibilities how to save them with for example alternative solves, and the conflict arise when the decision has made, sometimes too late to avoid the tragedy. To prevent this conflict, a good chance is the preparation and distribution of an SEA.

Strategic environmental assessment (SEA) has emerged in the last few years and there is no internationally agreed definition of SEA, but the next interpretation is among those which are widely quoted:

> "SEA is a systematic process for evaluating the environmental consequences of proposed policy, plan or programme initiatives in order to ensure they are fully included and appropriately addressed at the earliest appropriate stage of decision-making on par with economic and social considerations" (Sadler & Verheem 1996., citated by Dalal-Clayton & Sadler, 1999).

As a basic requirement for every SEA, which named the Great Bustard protection as one of the main aim is that cover the whole habitat of at least 1 population with the satisfactory buffer zone.

An SEA necessarily informs development proposal, assesses the effect of a policy, plan or programme on the environment or the effect of the environment on development needs and opportunities, assesses cumulative impacts and identifies implications and issues for sustainable development. It must focus on maintaining a chosen level of environmental quality, and must have a wide perspective and a low level of detail to provide a vision and overall framework.

4.4.1. Planning

Both in case of presence or absence of a SEA made for the concerned area, careful preparatory investigations should be executed in every case of a development conception. These investigations have to measure different building alternatives. Establishment in a right chosen place prevents most of the conflicts.

4.5. Environmental impact assessment

Environmental Impact Assessment EIA is an important and powerful policy tool. It is designed to be open and impartial, and aims to identify environmental impacts of projects and potential measures to avoid harm to the environment (Gill et al. 1996). The quality of the assessment is paramount, to enable an informed and objective decision to be made on the available information. Nonetheless, stringent environmental assessment is just as important for every development to ensure that it is sited optimally and to avoid or at least minimise any adverse impacts (Birdlife International 2003b).

Box 2: In relation to infrastructure developements and afforestations, the following criteria should be met (based on Birdlife International 2003b):

- All projects should be screened to determine whether they are likely to have a damaging effect on wild birds and the wider environment.
- If screening determines that the project should be subject to an EIA, then this should be carried out to the highest standards using current best practice.
- EIA must be initiated early in the project planning process and should incorporate full consultation with relevant government bodies and Non-Governmental Organisations (NGOs).
- The EIA must assess the potential effects of the investment and all associated infrastructure.
- The EIA should include, as a minimum, a 2 years baseline field survey to determine the habitat use of Great Bustard in the effect-zone and even the buffer-zone, since this species has high area fidelity and long life span. The baseline data collection is also important to enable a risk assessment.
- The results of the baseline surveys should be applied to the consideration of different proposal options. Options should include different site locations and different layouts, in order to prevent or at least minimise any potentially adverse effects.
- If there are any other projects which have been developed or are being proposed in the area, then the EIA must take into account any cumulative effects on birds that may arise.
- If potential or actual harmful effects to Great Bustards or their habitats are identified, then the EIA must address these. If the impact can be avoided, mitigated or remedied by suitable avoidance or mitigation measures, the EIA should identify these measures. In addition, the EIA should identify compensation measures to compensate for any damage.
- Suitable pre- and post-development monitoring of impacts on birds must be carried out, using the Before-After Control-Impact (BACI) approach. Monitoring feedback will inform whether further mitigation measures are required in the operational phase of the project concerned, if outcomes differ from those predicted by the EIA. Additionally, this information will help inform future development. Post-construction monitoring needs to continue for long enough to distinguish short- and long-term effects and impacts.
- Poor quality EIAs, or lack of information, must not be permitted to lead to planning approval on the grounds of no demonstrable effect. Adequate EIAs and planning decisions can be made only on the basis of robust data and rigorous assessment.

4.6. Mitigation of the effects

Necessary to note, in case of a new investigation or development of infrastructure, these recommendations are the less desirable ones, always the prevention must have the privilege. The following provisions shall have effect mainly at already existing infrastructures.

4.6.1. Power lines

The best mitigation measure for the collision risk is the changing the aboveground wires to underground wires, which eliminate this problem. In Great Bustard habitat or other important habitat of birds, in case of establishment of new low or medium voltage power line, this is the only acceptable method. This measure is also possible for high voltage power line technically, but it is rarely applicable because of the excessive costs. The costs seem to be high at the first moment also in case of medium or low voltage power lines. But in comparison to the erection of aerial wires, included the ideal values of the devastated birds and the costs caused by bird collisions and electrocutions, the price is not so high relatively. As an accessory investment of a wind farm building, the burying the new wires takes only 1-2 % of the total amount of the costs.

By the increasing of the visibility of front wires, the rate of the collision can be decreased in a large scale (Bevanger 1994, Hunting 2002, Yee 2008). Countless instruments are available with different attributes, for a classification of them made Hunting (2002), see the table 2 and some example for the swinging and rotating plates can be seen in the figure 3. below, and furthermore some bird protection instruments in figures 4-6.

Table 2: Summary of devices to increase power line visibility (source: Hunting, 2002).

Device Name	*Description*
Spiral Vibration Dampener (SVD)	Extruded plastic spiral device that fits over a ground wire.
Bird Flight Diverter (BFD)	Spiral device made from high impact PVC which attaches over ground wire.
Swan Flight Diverter (SFD)	Similar to the BFD but larger
Bird "flapper"	Pendant oblong device with four fins painted black and white on alternating surfaces
Avifaune Spiral	Similar to BFD, but in red and white colors.
Aerial Marker Spheres	Various size and color spheres that attach to ground wires
Swinging plates	Plates of various sizes and colors that attach to, and hang from, ground wires.
Ribbons, tapes, etc.	Various lengths, widths, and colors of hanging ribbon or plastic to increase wire visibility.

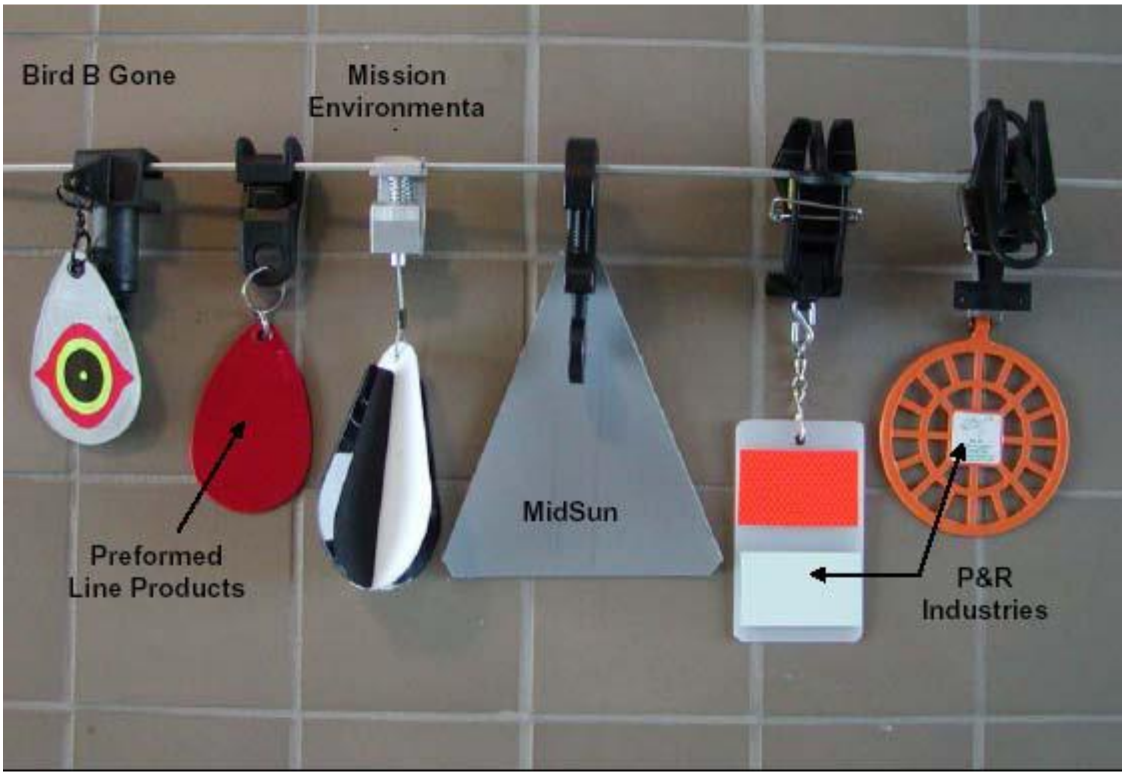

Figure 3: Some example from the USA for swinging and rotating plates for the mitigation of collision risk (source: Yee 2008). These are used mostly on medium or low voltage powerlines.

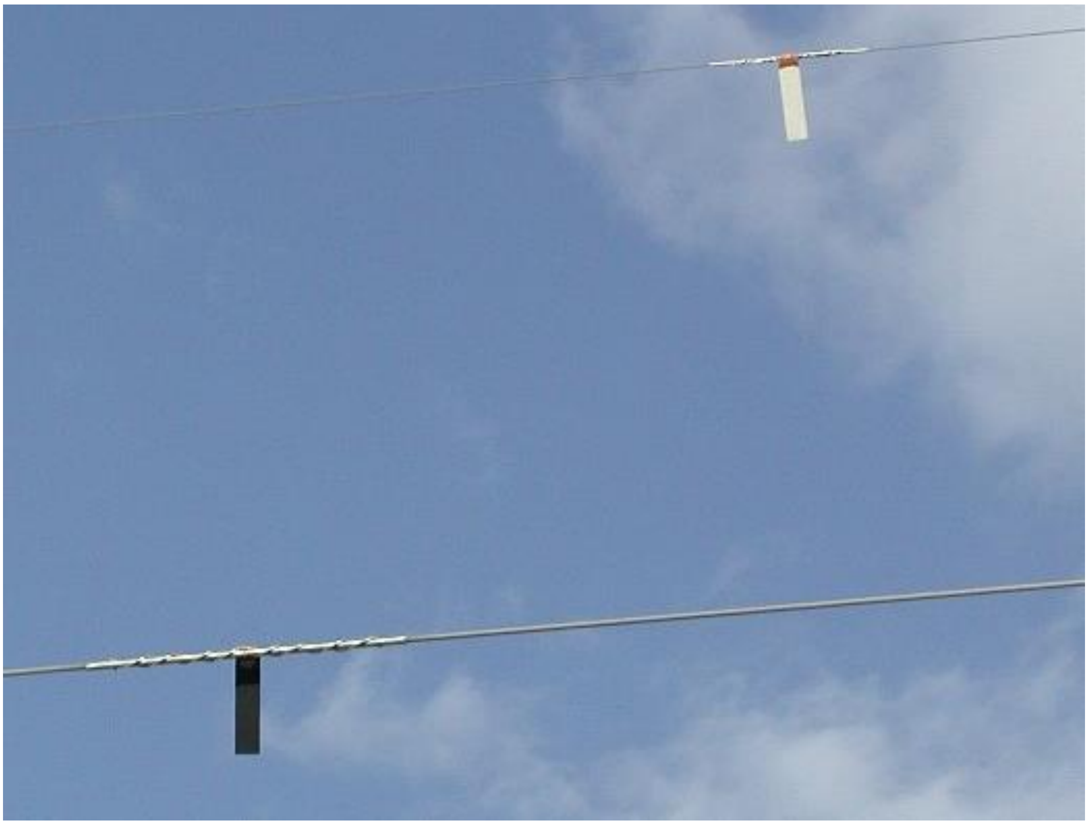

Figure 4: Bird protection flags on high voltage power line in Austria (Photo: H. Herzig).

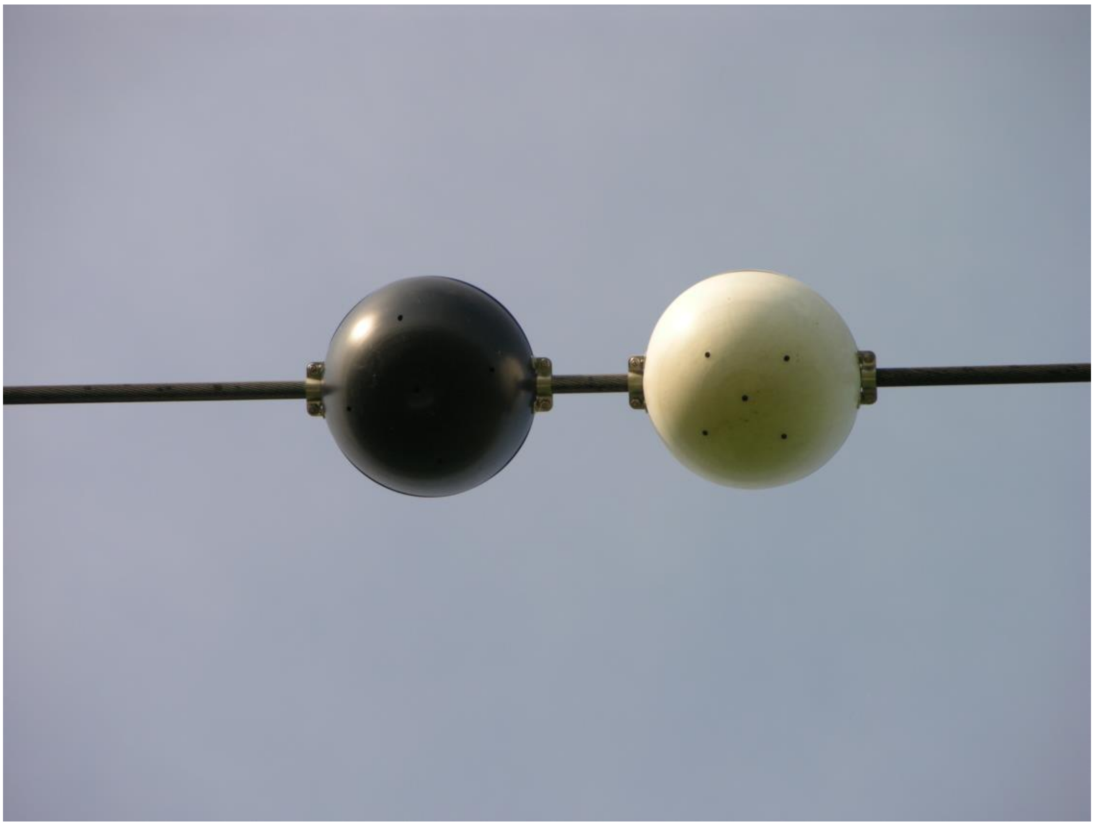

Figure 5: bird protection balls with 30 cm diameter (Photo: E. Julius) on high voltage power line in Austria.

Figure 6: bird protection balls and bird protection plates (Photo: R. Raab) on high voltage power line in Austria.

Ground wire marking of high voltage power line was adopted in 1990 in Extremadura, in Spain with coloured P VC spirals, and a consecutive study was carried out in the previous and in the following winter. Accordingly to the before and after study, flight intensity and collision frequency of the Great Bustards decreased by 61% and 60% at marked spans compared to the same spans before marking, while at spans without marking there was no significant change in collision frequency. After marking, the percentage of birds flying between the cables decreased, in contrary the flying above them increased (Alonso et al. 1994).

Consequently the removal of the ground wire of high voltage power lines could be an effective measure, as it is recommended by some author (e. g. Hunting, 2002), referring to field studies. Presumably the technical implementation of this measure will meet with serious difficulties.

As it was proven in some cases (e. g. Bevanger 1990), the topography has big role in the probability of the bird collision. The hiding of the dangerous power lines is lying on the base of this theory, for example a planted shelterbelt along the wires is a possibility (figure 7). We must note that the negative impact raised by a shelterbelt could be more significant, the plantation require detailed consideration.

Figure 7: Planted shelterbelts in the Havelländisches Luch Great Bustard habitat, in Germany for „covering" the railway electric cables. Photo: Eike Julius.

The constructions of the power lines shall obstruct only a minimum of air space in vertical direction, **single-level arrangement of cables**, as well as no neutral cable above the conductor cables are preferable.

The measures above are also relevant for the similar conflicts caused by fences and electric shepherds, and in most of the cases the effectuation can be much easier, since the weaker technical requirements.

4.6.2. Wind farms

There is a strong consensus that location is critically important to avoid deleterious impacts of wind farms on birds, meaning nearly the only one reasonable solving.

Some plausible measures to mitigate the collision risk, such as bright-coloured or reflective painting, night illumination or beaming alarm noise are not convincingly effective and probably make significant disturbance secondarily for both Great Bustard and other animals. Some turbine design aims to mitigate collision risk by making the structure unattractive for birds, but this is not relevant for Great Bustard because it avoids the turbines anyway

The restriction of function or the removal of the turbines, as it was happened in some cases in Altamont, United States of America, in Europe is hardly executable.

It is very important to give attention to the mitigation of the impact of accessory infrastructure, such as the power lines (see: 4.6.1.) or service roads (see: 4.6.3.).

4.6.3. Transportation infrastructure

The most effective mitigation measure for roads is the restriction of the traffic or the removal of the road. 'As an Action of the Great Bustard protection in Hungary', some gates were erected in different sites on field tracks, results the decrease of the disturbance significantly. In Austria, a contraction was signed between the nature conservation and the border guard, whereas the border guards changed the control area back from the border at Nickelsdorf, which is probably the densest breeding site of the Great Bustards in Austria. This measure can be a very effective and cheap solving, and can be executed rather easily in nature protected areas. Contrary this is less feasible at busy roads or highways.

Plantation row of trees, shelterbelts along the roads, as well as dykes, wood or plastic or concrete walls. These are preferable only at busy roads, at highways or at electrified railways for mitigating the risk of collision to the wires, otherwise the negative effects, due to fragmentation, would make these measures counterproductive. The plantation of tree lines or shelterbelts along grassy or field tracks should be always avoided.

Smooth surfaces have been developed to reduce noise while retaining safe traction control; in addition, some tires are much less noisy than others (Jacobson). Furthermore each engine emits noise and not negligible noise generated from the friction between the air and the surface of the car. The less noisy alternatives are preferable and their widespread usage should be promoted by regulations of the best available standards. The transmission of the emitted noise can be restrained by damper walls, similarly to the known ones in settlements along busy roads, made of concrete, wood or plastic. The speed limit by regulation is also a chance to reduce the disturbing noise.

4.6.4. Other infrastructures

In situations where land use and management have degraded ecological composition, structure, and function, it is necessary to develop coping strategies that promote ecological restoration and mitigate against further harmful impacts. However, restoration to the original ecological state is costly, takes time, may have a low probability of success, and sometimes is not even possible or useful (Dale et al. 2005).

The infrastructural elements belonging to this group endanger Great Bustard or its habitat variously. Recently an element appears usually only at some certain Great Bustard habitat, and not over Europe, but every habitat can be endangered by any of them, anytime. Several opportunities present itself for the mitigation of the damaging impacts, depending on the character if the infrastructure, which are partly similar to the written in the previous chapters. Mitigation strategies for impacted ecological systems need the joint effort of the scientific and decision-making communities to provide restoration of the impacted ecological system or amelioration of the deleterious effects on natural resources.

4.6.5. Afforestations, shelter belts, orchards, vineyards

Sometimes a forest, a shelterbelt or a plantation settled wrongly in a Great Bustard necessitate the mitigation of its negative impact. There is only one, but dramatic solution, the deforestation or out cutting, and thereafter Great Bustard habitat restoration in the freed fields.

4.7. Compensatory measures

Establishment of infrastructure even with the most carefully procedure results damages and disturbance on nature. Well designed compensatory measurements should be taken with an effort which results et least the same incomes for nature as much injuries it was suffered.

The first and most fundamental approach is to avoid adverse impacts. Avoidance can be achieved by simply not pursuing a certain development, by generating an alternative for the development or by limiting the intensity or magnitude of the development. If avoidance is not feasible, mitigation measures can be undertaken as a second planning concept. Such measures are designed to reduce or sometimes even eliminate the impacts of a given development on nature. Recently, a third concept has been developed. Based on the experience that impacts may still persist after mitigation, several states and countries have adopted a compensation principle, envisaged as counterbalancing the adverse impacts of developments on nature (Cuperus, 1999). This concept explicitly incorporates nature conservation interests in decision-making on spatial developments. However, the principle has raised urgent questions about the basis for its implementation.

Such compensation aims either to improve damaged areas or to create new habitat with ecological functions and quality attributes. Fundamentally, this does not differ from ecological restoration or habitat creation (Anderson 1995), except that it is associated with adverse impacts on nature due to development.

The result of certain infrastructure alternatives being abandoned during the planning stage as unrealistic given the scale and cost of the compensation measures implied, confirms that the compensation principle indeed leads to avoiding ecological damage in protected areas. At the same time, though, the present procedure provides a financial incentive for developers to seek infrastructure alternatives having minimal ecological impact, thereby reducing overall compensation costs (Cuperus, 1999).

The policy framework of the ecological compensation principle needs to be elaborated in greater detail, especially with respect to (by Cuperus et al. 1999):

- the precise definition of the affected ecological values;
- substantive criteria and procedural guidelines to help project initiators make choices on:
  - the kind of compensation to be implemented,
  - the point in time and efforts to be made before project initiators are relieved of the obligation to undertake physical compensation,
  - the physical location of compensation sites,

● protection of the compensation sites in the longer term, particularly with respect to arrangements for long-term management, funding and planning restrictions,

● the relative proportion of mitigation and compensation measures;

○ the status of ecological compensation within the overall policy framework

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