REVIEW

Lessons from 15 years of human–elephant conflict mitigation: Management considerations involving biological, physical and governance issues in Africa

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Abstract

The systematic study of human–elephant conflict (HEC) and its mitigation began in the mid-1990s. The IUCN African Elephant Specialist Group and its Human–Elephant Conflict Working Group took the lead in research required and the subsequent dissemination of tools to manage the problem. Over 15 years we have now seen widespread application of HEC mitigation methods by wildlife practitioners and affected communities all over the African elephant range. This paper re-evaluates and refines some established mitigation methods and introduces innovations that have appeared recently. The evolution of the arsenal of HEC mitigation methods suggests that currently relevant developments fall into three categories: biological, physical and governance. These broadly reflect new knowledge about problem animals themselves, better application of fencing and olfactory deterrents, and evaluation of options for damage compensation and land-use policy. We now have a much-improved understanding of the behaviour of 'problem' elephants which points to the futility of killing them. Credible evaluation of the use of fencing models and designs is now possible. The package of low-tech and sustainable defences based around the olfactory deterrent of chilli is well established and producing good results in smallholder agricultural situations. The deterrent potential of bees is assessed. Recommendations for the critical area of HEC mitigation through new official policy and governance initiatives are mostly in the proposal or experimental stage; this relates to political rights and land use and is the most urgent and crucial part of containing the problem across the continent. It is being marketed to elephant range States under an umbrella term – the Vertical Integration Model. Effective HEC mitigation is difficult to understand and problematic to implement; it remains a complex package of apparently disparate measures that have to be used in combination and flexibly, at different scales. Future HEC mitigation will be as much an art as a science, but since we now have a solid research foundation, we can proceed with some confidence to address the inherent socio-political difficulties.

Additional key words: re-evaluation, innovations, governance initiatives

Résumé

L'étude systématique du conflit homme-éléphant (CHE) et son atténuation a commencé au milieu des années 1990. Le Groupe de Spécialistes de l'Eléphant d'Afrique de l'UICN et son Groupe de travail sur les conflits

Homme-Eléphant a pris les devants afin de trouver des outils pour gérer le problème et les diffuser plus tard. Depuis 15 ans, nous voyons l'application généralisée des méthodes de gestion des CHE par les praticiens de la faune et les communautés affectées partout dans l'habitat des éléphants d'Afrique. Ce document réévalue et raffine certaines méthodes d'atténuation établies et introduit des innovations qui sont apparues récemment. L'évolution de l'« arsenal » de méthodes de gestion des CHE suggère que, actuellement, les développements appropriés se répartissent en trois catégories: biologiques, physiques et de la gouvernance. Elles reflètent largement: de nouvelles connaissances sur les animaux à problèmes eux-mêmes, une meilleure application du clôturage et des répulsifs olfactifs, et une évaluation des options pour le dédommagement et une politique foncière. Nous avons maintenant une meilleure compréhension du comportement des éléphants « à problèmes » qui pointe à la futilité de les tuer. Une évaluation crédible de l'utilisation des types de clôtures est maintenant possible. L'ensemble des défenses viables et rudimentaires basées sur la dissuasion olfactive de piment est bien établi et produit de bons résultats dans des situations agricoles des petits exploitants. Le potentiel dissuasif des abeilles est évalué. Des recommandations pour le domaine critique d'atténuation des CHE grâce à une nouvelle politique officielle et des initiatives de gouvernance sont pour la plupart au stade de proposition ou expérimental, ce qui a trait aux droits politiques et à l'utilisation des terres et c'est la partie la plus urgente et cruciale pour contenir le problème à travers le continent. Il est « vendu » aux états de l'aire de répartition sous le terme générique — de modèle d'intégration verticale. Une atténuation efficace du CHE est difficile et problématique à comprendre et à mettre en œuvre, il reste un ensemble complexe de mesures apparemment disparates qui doivent être utilisées en combinaison et avec souplesse, à différentes échelles. L'atténuation future du CHE sera autant un art qu'une science, mais puisque nous avons maintenant une base de recherche solide, nous pouvons procéder avec une certaine confiance pour faire face aux difficultés socio-politiques inhérentes.

Mots-clés supplémentaires : réévaluation, innovations, initiatives de la gouvernance

Introduction

The systematic study of human–elephant conflict (HEC) only got fully underway in the mid-1990s. Since then, three approximately five-year periods have seen the evolution of understanding of the problem and, most importantly, how to then address it in the light of current knowledge. These three phases broadly focussed on 1) studying problem elephants and quantifying damage levels to crops and property within the conflict zone; 2) producing AfESG 'tools' to help wildlife managers to apply a package of HEC mitigation measures; and 3) applying, assessing and refining these mitigation measures, including introducing innovative methods.

A milestone that marked the beginning of phase 2 was the compilation of all current HEC knowledge and recommendations into a 'decision support system' (DSS) for managing HEC situations in Africa that was produced in English but also translated into French and Portuguese, so as to assist practitioners across the African elephant range (Hoare, 2001b). This document separated 10 'categories' of mitigation measures, each with a considerable number of 'method variations'. The 10 DSS categories remain the solid foundation of 15 years of HEC mitigation efforts are:

1. Systemic data collection and contextual research
2. Traditional deterrent and disturbance methods used by rural communities
3. Disturbance and chasing of problem elephants by wildlife authorities
4. Killing of problem elephants by wildlife authorities
5. Translocation of problem elephants by wildlife authorities
6. Fencing options
7. Olfactory deterrents (chilli methods)
8. Compensation schemes
9. Wildlife utilization and benefit programmes (community conservation)
10. Land-use planning and changes

An important distinction is between measures applied within the conflict zone (1–7) and those relying heavily on official policy and administration beyond the conflict zone (8–10). A second important division is between short-term methods (traditional, disturbance, killing, translocation and chilli) and long-term ones (research, fencing, community conservation, land-use planning).

While not discouraged, shorter term measures applied locally within the conflict zone have not proven adequate or sustainable to really contain the HEC problem, indicating that the longer-term but far more complicated and difficult measures necessary at a larger, national scale are the right options to pursue. In attempting to update HEC mitigation since the 2001 DSS, I have not re-assessed all the options above but concentrate here on new knowledge, some assessment of older methods and recent innovations that have appeared. While using three apparently new headings to describe these, they still fit into the above established HEC management categories as follows:

New biological considerations include research into habitual raiders (1), the use of bees as a deterrent (2), and killing problem elephants (4)—all within the conflict zone.

New physical considerations include an assessment of fencing (6) combined with olfactory deterrents (7)—applied within the conflict zone.

New governance considerations include all longer-term issues with complicated components outside the conflict zone—compensation (8), community conservation schemes (9) and land-use changes (10)—now proposed under an umbrella term, the 'vertical integration model' (VIM). What the VIM attempts to do is simplify and harmonize co-operation between administrative levels to apply the package of HEC mitigation measures that shows, on the basis of ongoing trials, the best chances of success.

Biological mitigation

Habitual raiders in an elephant population

In the vast majority of populations where elephants are not individually studied and thus not recognizable, recording elephant group size, footprint size or dung bolus size after night-time crop raids has been used as an indicator of the sex frequency of raiding behaviour. This evidence has led to the firm conclusion that males are disproportionately represented in conflict incidents in most HEC zones. But there is now reinforced evidence that elephant crop raids are carried out by a small segment of the population—the 'problem component' as it were, consisting largely of individuals who are termed 'habitual raiders'.

This was first proposed by Hoare (2001a) on the basis of considerable circumstantial evidence, and initially substantiated by cases where radio tracked animals returned to raid crop fields despite even their own group members being killed. More evidence then accumulated that repeated raiding by males increases with age (Chiyo & Cochrane, 2005). And in a landmark recent study, Chiyo et al. (2011a) surveyed crop raiders in Amboseli National Park, Kenya, where each member of the elephant population is individually known. They established via genetic sampling of dung in fields that one-third of the males were crop raiders. Of this third, a mere 10 animals (12%) were responsible for 56% of recorded crop raids and two individuals were responsible for 20% of the raids. The remainder of less frequent offenders—all males—were classed as 'occasional raiders'.

This limited number of male crop raiders in Amboseli is consistent with the earlier hypothesis put forward separately by Sukumar (1990, 1991) in India) and Hoare (1999a) in Africa implying consistency with the expectations of foraging theory and that by extension, an elephant male reproductive strategy is being pursued (Chiyo & Cochrane, 2005) that involves risk (Ahlering et al., 2010). This is referred to as the 'male behaviour hypothesis'—a sort of default position resulting from the failure of several attempts to quantify a clear causal relationship between variables associated with crop raiding. Hypothesized conflict variables that have been quantified (elephant density, human density, interface length, rainfall, farming system, crop types) consistently show little relationship to the number of elephant raids (Hoare, 1999a; Chiyo et al., 2005; Sitati et al., 2005). The strongest evidence to support a behavioural hypothesis is that the most intuitive of all numerical relationships—the number of elephants in a population compared with the number of conflict incidents perpetrated—has so far failed to show any linear or other convincing causal relationship. Using the well-studied Amboseli population, researchers have now proposed plausible behavioural explanations for risky crop raiding by both younger and older male elephants. These are mainly social learning and life history factors (Chiyo et al., 2011b, 2012).

Crop-raiding variables are also strongly environmentally spatial rather than numerical (Hoare, 1999a; Sitati et al., 2005); factors like habitat, daytime refuges for elephants, water distribution, human settlement patterns, physical defences, or cultural and agricultural practices may be locally important determinants of HEC levels (Naughton-Treves, 1998; Chiyo et al., 2005).

Amboseli is an arid area where crop farming is not the primary land use, but such clear support for a long-suspected hypothesis will very likely mean that problem elephant behaviour is similar across most agro-ecological situations in Africa. An important additional consideration for HEC mitigation is that male habitual raiders are far more likely to become adept at circumventing defences deployed against elephants. Cow-calf elephant groups do crop raid occasionally in some locations, but overall in the African and Asian elephant range they do this far less frequently than do males.

The futility of killing problem elephants

Empirical evidence suggesting the futility of killing elephants as a routine method of problem animal control (PAC) was illustrated by Hoare (2001a) who showed experimental data on a crop-raiding group of bull elephants. One animal was shot dead while crop raiding at night, and the movements of its radio-collared companion were subsequently monitored. By the fourth night thereafter (during the height of the crop-raiding season) the animal had returned to raid fields within one kilometre of the shooting incident (Fig. 1). Removal of the animals from the 'problem component' (Hoare, 2001a) thus does not reduce the numbers of raiders, because other recruits in the 'occasional raider' sub-population (Chiyo et al., 2011a) merely replace them.

Very often wildlife management authorities cannot or do not correctly identify individual raiders and any nearby elephant is killed to appease the affected community. This becomes institutionalized by wildlife authorities into what has been termed a 'ritual palliative' (Hoare, 1995), that is, simply shooting a number of elephants every year in each conflict zone. Because the method is cheap, quick and has temporary but substantial public relations value, this outdated idea from colonial times has unfortunately persisted to the present day (Hoare, 2001b). Poaching of elephants is universally condemned but the fairly random shooting of elephants as crop raiders is widely tolerated, and in some countries the annual total of the latter can far exceed the former (AfESG, 2010). The two issues can become interlinked when destruction of crop raiders is used as a pretext for local poaching (Malima et al., 2005).

The myth that shooting crop-raiding elephants will be beneficial to HEC mitigation is perpetuated at all levels and even unfortunately quoted in official policy pronouncements. In 2011 the wildlife authorities of Botswana stated that the legal hunting quota for elephant (27 animals) was to be made up entirely of male crop raiders, in the belief that this would help control these problem animals (Bungu, 2011). Botswana is a largely non-agricultural country with the largest elephant population on the continent (>120,000 animals). As shown by the studies of crop-raiding behaviour, this strategy will not have any effect at any level—that of an individual animal, local area or nation. But these authorities may be experimenting with using sport hunting by commercial operators to assist PAC, which then provides additional government revenue.

It is easy to criticize such authorities but they have a difficult job balancing human and wildlife conservation needs. To try to compromise on emotive political issues like HEC and PAC, Zimbabwe tried innovative schemes in the 1990s. Quotas for elephants to be destroyed on PAC in individual districts were set by the central authorities alongside annual legal hunting quotas, the total not exceeding a sustainable level of population off-take (Taylor, 1993). These PAC elephants could also be marketed on safari hunts to earn additional revenue for district councils. The communities affected thus did not lose a bonus of free elephant meat or the aspect of some 'retribution' against elephants but had to acknowledge that PAC must also be subject to limits. Such an interim quota system leaves the option open for authorities and communities to gradually phase it out through negotiation.

Very aggressive elephants in rare cases of posing a real danger to human life may well merit destruction, once they are surely identified. Sometimes these animals have become dangerous because of being wounded during previous attempts to chase them from agricultural areas.

Use of bees as an elephant deterrent

Research work in Kenya on the use of African honey bees (*Apis mellifera*) as a deterrent to crop-raiding elephants has recently been published. The scheme uses beehives incorporated into a simple fence in such a way that elephants contacting the barrier disturb the

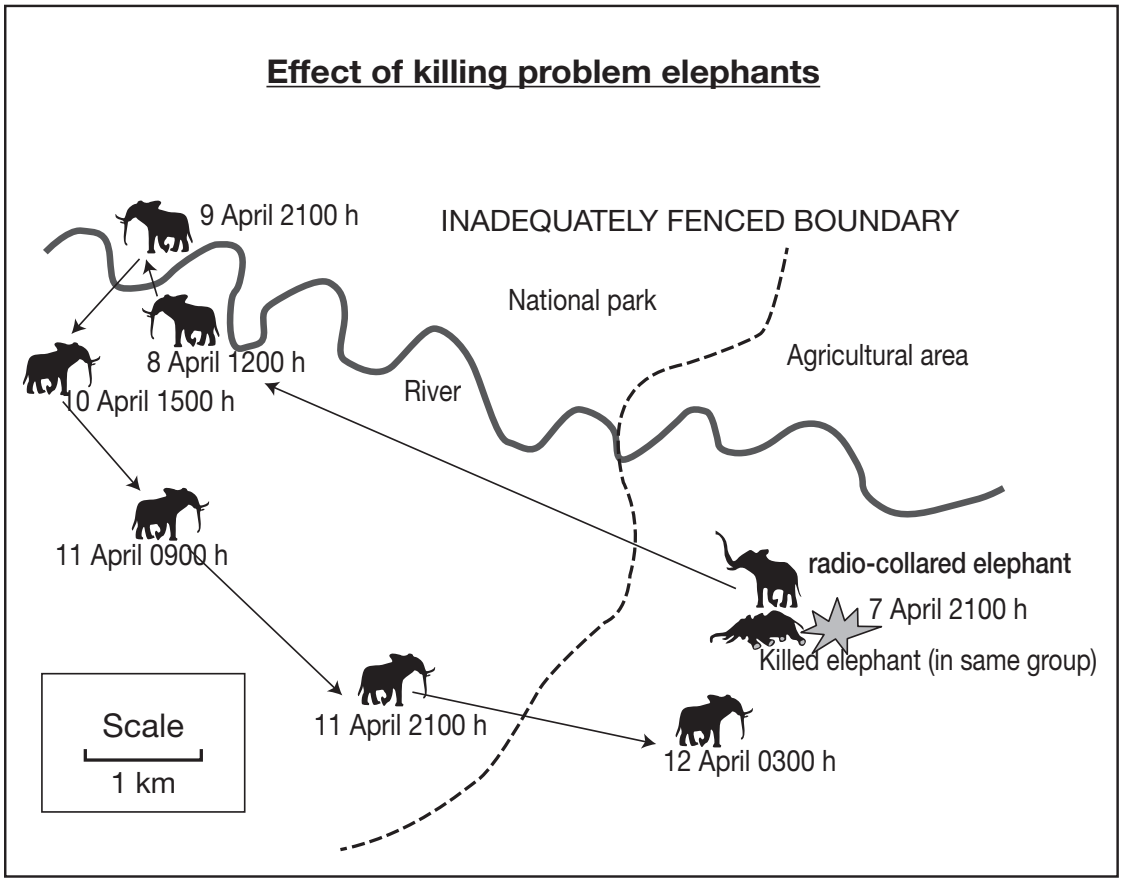

Figure 1. Initial evidence previously published (Hoare, 2001a) showing that some male elephants can be habitual crop raiders and that killing them serves as no deterrent to their companions. Stronger support for the hypothesis and its management implications has recently emerged through genetic investigation of crop raiders (Chiyo et al., 2011a,b; 2012).

insects in their hives. The fence design was proposed because playback experiments using the sound of bees had previously caused elephant groups to either apparently retreat from the source of sound or make alarm calls (King et al., 2007, 2010).

In the first research trial (King et al., 2009) the beehive fence was 90 m long, partially protecting one farm and consisting of nine empty beehives. During six weeks of monitoring, data were collected only from this one partially protected 2-ha farm and compared with one 2-ha control farm. Many variables between the two farms were not controlled for, and the 'protected' farm suffered more than half as many crop raids (7) as the control farm (13). Yet the authors claimed an effect—explained by 'anti-bee conditioning' of elephants based on the fact that beehives were present.

A second bigger trial was undertaken (King et al., 2011) involving 17 smallholder farms with beehive fences compared with 17 control farms with thorn bush barriers on the boundaries. Although far more raiding elephants gained access through thorn-bush fence as opposed to beehive fence sections, there are too many confounding variables to support the conclusions claiming success of the latter design. Fence sections were very short and thus elephants easily walked to the ends; crops failed in two out of the three crop seasons monitored; many beehives were unoccupied; bees show low activity at night; and the total of crop raids during the trial was very low (32).

In an earlier experiment in Zimbabwe, Karidozo & Osborn (2007) had recorded some avoidance of beehives placed on elephant paths, but showed that elephant raiding on small, isolated plots of crops was not significantly different between beehive-protected

plots and control plots. They concluded that the spatial influence of hives was small and thus the use of bees on an effective scale for general crop protection is questionable.

Both popular and science journalists (Anon, 2007, 2010, 2012) have portrayed the Kenyan 'beehive fence' as the new, single solution to HEC, thus ignoring the fact that HEC mitigation necessarily has to embrace many different measures (as acknowledged by King et al. by 2010).

HEC innovations affordable to small-scale farmers certainly deserve support, particularly those that have an income-generating possibility, but the results of bee research so far do not match the hype. These limited trials are far from conclusive and far more evidence is needed to see if problem elephants become habituated to the presence of largely inactive beehives at night, as they often do to other frequently used, more active 'traditional' deterrents (Hoare, 2001b)—for example human-generated noise, the use of fire or manned watchtowers.

Physical mitigation

Fencing to deter problem elephants

Extensive experimentation with elephant fencing in Zimbabwe in the 1990s (WWF, 1998) showed that elephant fencing could be broadly classified into five types, based on 1) layout in the landscape and 2) physical specifications (AfESG, 2000b).

- Model 1. Extended full barrier fence (long, often separating land uses like national parks from agriculture)
- Model 2. Partial interface fence (open-ended but incorporating natural barriers, e.g. escarpment, lake)
- Model 3. Community protection fence (encircling a whole village with crops and facilities)
- Model 4. Household ownership fence (encircling dwelling and crops of one household)
- Model 5. Crop protection fence (encircling only small crop-growing areas)

We are now in a position to offer some evaluation of the long-term success of these models.

Communities suffering HEC frequently demand that governments fence their protected areas (model 1). But it is virtually impossible to confine elephants to a protected or designated area by means of fencing. This has only been achieved in very few places that share certain rare characteristics: an encircling fence layout, specification of a very high fence, a rigorous maintenance regime, and separation of abrupt land-use changes (a 'hard edge' boundary); it needs to be justifiable economically by multipurpose objectives. Examples are the Knysna Forest in South Africa and the Aberdare National Park in Kenya. In the latter case, massive investment in a multipurpose barrier encircling a mountain ecosystem contains elephants as an extra benefit of its primary objectives to exclude humans from degrading the montane forest and poaching rhinos.

The difficulties of fencing elephants into protected areas was spectacularly demonstrated in the early stages of the Greater Limpopo Transfrontier Conservation Area: some elephants translocated across an impenetrable boundary fence from the west side (Kruger National Park, South Africa) to the east side (Limpopo Park, Mozambique), turned back and walked 150 km along the fence until they reached the end, thereby successfully returning to their former range. Thus short-distance boundary fences such as employed along some national park boundaries have shown poor performance in reducing HEC. The effect of 'funnelling' elephants towards the ends of these Model 1 fences has exacerbated HEC and so worsened community relations in some conflict zones in Kenya (Smith & Kasiki, 1999).

In all five fence models, monitoring has shown that the deficiencies of detailed and regular maintenance inevitably manifest themselves and make it impossible for ordinary or electric fencing to withstand elephant challenge after a period of initial success (WWF, 1998; AfESG, 2000b). Vandalism is a serious problem and the bigger the project the more likely it will eventually fail through vandalism and/or lack of maintenance. The only consistent exceptions are smaller fence projects under strongly motivated and permanent management, such as ownership by individuals or commercially run irrigation schemes.

So the experience of the last 15 years has shown that while electric fencing is certainly technologically capable of being an effective elephant deterrent, its application in practice is restricted. Model 3 is intuitively the most desirable in rural African situations, but it has consistently failed (after initial success) due to poor maintenance. These maintenance deficiencies

are almost always caused by weak institutional arrangements (to do with contracts, wages, work schedules, disputes or corruption) rather than by any technological shortcomings.

Elephant fencing is successful only if it is encircling in layout (with models 1, 3, 4 or 5) to avoid elephants walking to the end, and where scrupulous daily maintenance is possible. Most often this means employing fencing only in a small project. Thus encircling small target areas of households with crops, crops only, communal grain stores or water points, is the best fencing strategy in HEC. In Zambia there is an innovative and successful project to replace traditional basket grain stores in villages with 'elephant safe' designs built from brick and cement (SLCS, 2011).

Smallholder farmers can protect their land from problem elephants with simple single- or double-strand electric fencing if they can get small amounts of initial capital finance or aid, and if they maintain their own encircling fences. A combination of simple electric fence and chilli deterrent methods, using low-specification temporary string fences, would constitute a back-up system almost guaranteeing freedom from elephant crop raids.

Chilli-based olfactory repellents against elephants

We are now able to draw on more than 15 years of experience using chilli-based olfactory repellents to deter elephants from entering crop fields or human habitation. There have been several qualitative and, as much as is possible with such a low-technology intervention in subsistence farming areas, a few quantitative assessments of the effectiveness of the chilli repellent method (Sitati & Walpole, 2006; Malugu, unpubl. data, 2010).

The active ingredient of chilli (capsaicin) was first developed in concentrated aerosol form to prevent personal attacks on humans from bears in North America or for use in law enforcement (pepper sprays). Chilli aerosol deployment in the larger quantities required to reach elephants some distance away, however, soon gave problems (Osborn, 2002). The chilli gas cloud, although quite cohesive, is wind-dependent and thus directional control is difficult. Secondly, elephant anatomy does not allow much gas contact with the target (the sensitive mucous membranes of the eyes, nose and mouth), and on encountering a suspicious-smelling substance with sensory receptors in the tip of the trunk, elephants do not inhale it.

Capsaicin from chilli is fully soluble only in oils; thus, cheaply available oil-based media are used to deploy the deterrent. Mechanical grease was initially thought ideal but the high cost has meant that discarded engine oil was soon preferred and is now used successfully. Concentrated chilli extract is mainly deployed via two methods. The most common is on very simple and cheap fencing that uses sisal string strung between bush-cut poles or existing trees surrounding crop fields. Only one or two strands of oiled sisal string at about 1.5-m height are needed, but intermittently placed cloth squares soaked in the chilli oil can be added to enhance the smell. A second method can be employed where elephant invasion routes to farms are regular or known. Dried and concentrated chilli extract is mixed into a wet bio-brick made of elephant dung, cow dung or dry plant material. Chilli bricks are sun dried and then placed on the burning embers of a fire at the edges of crop fields at night. If the prevailing breeze is fairly consistent, the noxious smoke acts as a deterrent to approaching elephants.

Osborn & Parker (2002a,b) developed a simple package of chilli-based measures suitable for smallholder farms in an agricultural subsistence economy. An NGO was set up that organized training courses not only in elephant conflict-mitigation methods using chilli but also on the correct growing procedures for suitable chilli varieties (www.elephantpepper.org). Supervisors of HEC research and mitigation projects from many African countries have attended these courses and the manuals that accompany the courses, discussing all details of HEC mitigation, are available free online (Parker et al., 2007a,b). In southern Africa a company was also formed to buy chilli grown in excess of the farming community's need for it in HEC applications, and this enterprise extracted the oil for commercial sale. So in some cases chilli had additional benefit as a cash crop.

The chilli package stresses that reliance on chilli smell alone may not be fully effective and some simple supplementary efforts are still needed from farmers themselves (Parker et al., 2007a,b). An area 5 m wide cleared of any thick vegetation surrounding crop fields helps with elephant detection. Cow bells or an equivalent sounding device hung on the chilli fence can alert sleeping farmers to an elephant contacting the flimsy string barrier. Farmers should maintain good vigilance during crop maturity (e.g. taking turns

to man watchtowers) and physically shine lights and produce loud noise (e.g. from drums, firecrackers, whips, homemade 'bombs') when confronting raiding elephants. The severity of elephant raids can also be reduced by an efficient early- warning system using mobile telephones (Graham et al. 2011). Such rapid communications also improve HEC incident verification by research projects (Hoare, 1999b) and response times by wildlife authorities.

Even if chilli odour isn't always fully inhaled, elephants are aware of the substance, and this helps to maintain a key element of the chilli strategy—the elephants' association of human resistance with the smell of chilli. The package of measures that works successfully has been termed 'farm-based mitigation methods' or 'community-based conflict mitigation' (CBCM). Areas to which the chilli package was properly applied have been small because initial projects were donor or NGO-assisted schemes, and thus evaluating the wider applicability, uptake levels and success across the elephant range was difficult. As with bees, initial media hype was again a problem, as it created great expectation that chilli was the panacea to HEC.

But despite some inevitable methodological challenges affecting uptake by farmers, well explained by Graham and Ochieng (2008), there is now much circumstantial and some quantitative evidence supporting chilli as an effective and certainly sustainable deterrent in smallholder agriculture (Sitati & Walpole 2006; AfESG, 2010). For example, four years of monitoring CBCM use in western Serengeti, Tanzania, showed increasing uptake by farmers reduced the total elephant crop raids in 22 villages by 89% (fig. 2a) (Malugu, 2010).

The actual area of crop damage on these farms (fig. 2b) showed great fluctuation explained in this case by wide variation in 1) rainfall (two droughts), 2) reporting effort by farmers, and 3) slightly differing data capture periods. In conflict zones in different years fewer raids might be individually more damaging or conversely more numerous raids individually less damaging. This illustrates the difficulties of merely quantifying crop damage and so reinforces that the social dimension of an elephant conflict problem (Hoare, 2001b) must also be investigated and understood. This social dimension includes opportunity costs that are difficult to quantify—like loss of sleep or exposure to malaria while guarding crops, dangers to rural travel on foot or reduced school attendance.

This research illustrated two very important additional concepts for managers. First, there is no panacea: HEC can be reduced but one should never create the expectation that it can be eliminated altogether. But significantly, here it was reduced towards the communities' target of a 'tolerable problem' by affordable low-tech methods. Second, this low cost, sustainable option added considerable weight to discrediting a previous, enormously expensive proposal to fence the Serengeti National Park western boundary with a model 1 open-ended barrier— a type that would very likely fail to reduce HEC. This evidence was retrospective so it was fortunate that the fencing was never implemented.

To extend knowledge of the chilli package across vast areas experiencing HEC but which donor-backed projects cannot reach, a simple film is being prepared for showing in rural African villages. The film will be a generic product to which a soundtrack in any language can be attached. An explanatory leaflet for farmers will accompany the film show.

Mitigation through policy and governance

Monetary compensation for elephant damage

Monetary compensation has been tried at many scales but has never been successful in practice; evaluation of the concept and its implementation appears on the AfESG website (AfESG, 2000a). In common with those for other taxa (Dickman et al., 2011; Treves and Karanth, 2003) monetary compensation schemes for elephant damage suffer from considerable deficiencies. These can be divided into reasons for 'a flawed concept' (1–3 below) and reasons for practical problems (4–9 below):

1. Compensation is unable to decrease the level of the problem; the cause of the problem is not being addressed—it does not do *anything* to decrease the *likelihood* of elephant raids.
2. Compensation reduces the incentive for self-defence by farmers and therefore could even exacerbate the scale of the problem—the so-called moral hazard.
3. Compensation cannot address the unquantifiable social 'opportunity costs' borne by people who are affected by the threat of problem elephants (Hoare,

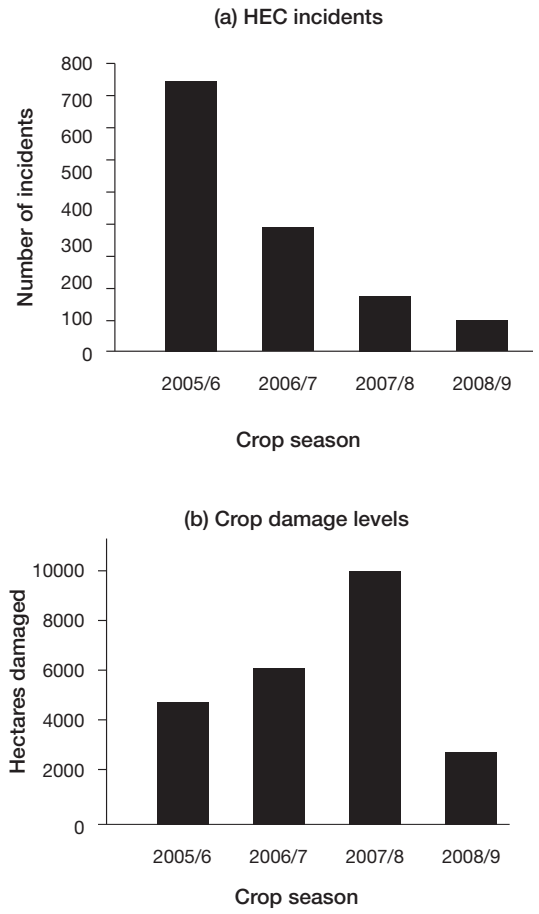

Figure 2. Reduction in HEC incidents and variation in elephant damage in 22 villages using chilli-based CBCM methods in western Serengeti, Tanzania (data from T.L. Malugu, 2010).

2000). This is a considerable component of HEC.

4. Compensation is cumbersome, expensive and slow to administer, because of the need to train assessors, cover large areas and have stringent financial controls, and once embarked upon, potentially has no end point.
5. Compensation is open to considerable abuse or blatant corruption (e.g. through bogus claims, inflated claims, deliberate cultivation in places where crops are likely to be damaged)
6. There are usually never sufficient funds to cover all compensation claims.
7. Payment of compensation to only some victims may cause resentment or social problems among recipients.
8. The value of payments is eroded by inflation and meagre payouts cause resentment among recipients.
9. Where compensation schemes need to be promulgated in law, their ability to keep pace with changing economic circumstances or changes in social policy is hopelessly slowed down.

For the above reasons, the AfESG regards monetary compensation for most cases of elephant damage—especially crop damage—as a flawed concept and recommends against using it (AfESG, 2000a). The AfESG believes that, unlike most other countermeasures against elephants, compensation can only at best address the symptoms and not the cause of the problem. It could even be argued that, at worst, monetary compensation exacerbates the problem of elephant crop damage. Use of a compensation scheme that fails can be far more damaging to the wildlife authorities' relationship with rural farming communities than no compensation at all.

One African country still paying across-the-board wildlife damage compensation is Botswana, a largely non-agrarian economy whose government is relatively wealthy. But their wildlife authorities admit that the scheme is for public relations value and does not actually address the problem at its core. Rwanda recently introduced a national wildlife damage compensation scheme. In Uganda a recent study found that compensation is unaffordable for the wildlife authority, and furthermore unsustainable as crop raiding is escalating. This research (Mackenzie and Ahabyona, 2012) proposed that the best use of funding to mitigate HEC costs in local communities would be to assist the implementation of crop-raiding defences.

So in the face of the above contradictory evidence, it would appear that entirely political motives drive the introduction or retention of monetary compensation schemes.

Modified compensation schemes

The AfESG does not, however, totally reject the idea of compensation in all human–wildlife conflict situations. Financial instruments customized for livestock losses to carnivores have had some success (Dickman et al., 2011). Some governments have tried to retain compensation for the most serious incidents—loss of human life—as was the case in Kenya when the national scheme for crop damage compensation was scrapped. While this initially saved government money

and reduced some effect on victims' families, the idea soon lost credibility due to monetary inflation.

Replacement compensation

Compensation in the form of basic foodstuffs is an accepted way of relieving the effects of natural disasters like floods or drought. Once HEC was systematically studied by researchers, it was discovered that it usually only seriously affects relatively few people in a community. If such people can be identified and fair assessments of their plight made without cheating, there may be a place for locally administered relief schemes that involve foodstuffs rather than money. There are unfortunately no quantified case studies from which to evaluate this idea. Thus, other forms of replacement may be appropriate where more unusual types of elephant damage occur, for example damage to water supplies, food storage facilities, or fences and in rare cases of killing of livestock by elephants.

Consolation

In Tanzania there was no compensation for any form of wildlife damage to human life or property until 2009 when a new Wildlife Act was passed. This introduced the idea of 'consolation'—a financial payment to assist hardship suffered through losses from dangerous wildlife. Regulations appended to this act are currently being worked out to govern consolation payments, which involve setting fixed government payments to victims for quantities of different types of crops destroyed, numbers and categories of livestock killed and human injuries and deaths. To try to avoid the above pitfalls of centralized compensation (low government funding, resources to verify rising claims, monetary inflation) the model is being designed to operate around community-based organizations that are partially based on community-funded financial schemes.

Political strategies for HEC

When the systematic study of HEC started in the 1990s it was hoped or assumed that solutions would be found locally within the conflict zone—somehow dealing with problem animals within the elephant range (Hoare, 1995). But now we know that a few individual elephants, especially the older, bolder habitual raiders, may become adept at circumventing most defences. If the political reaction is severe enough, the authorities may decide to destroy them. But now we also know that even if this is achieved, these offenders will likely be replaced, and so the problem will persist. Therefore with time it became obvious that the solution to HEC did not lie with trying to tolerate or 'manage' individual animals, who are after all displaying natural behaviour (Chiyo et al., 2011b).

With time, three overarching principles of mitigation clearly stood out in many HEC situations across Africa:

1. no method is 100% effective at all times, so one should aim to reduce HEC to tolerable levels rather than unrealistically try to eliminate it completely
2. combined package of apparently unrelated measures (1–10 in introduction) must be applied flexibly at different scales
3. crucial participants are found at all levels of government and society, and some of the most influential are situated far beyond the conflict zones.

Put simply, the problem is all about land use, and in any country the solution must involve people at many different administrative levels.

As shown by collated information, the best approaches in HEC are to largely replace short-term measures with longer-term strategies (O'Connell-Rodwell et al., 2000; Hoare, 2001b; Osborn & Parker, 2002b; Dublin & Hoare, 2004). Longer-term approaches (wildlife utilization programmes, land-use planning) centre around various models of 'community conservation'. These approaches are far more difficult to implement but are ultimately more successful and sustainable. Rather than trying to impose a strategy of people constantly fighting politically against the presence of elephants that will often persist in human-dominated habitats and thus cause problems *even at low densities*, such approaches accept and therefore try to *accommodate* elephants as a *species*, within the landscape.

The vertical integration model of HEC management

In many African governments the necessary institutional links between local, provincial or regional, and national entities are too diffuse and poorly integrated to address the above complexities of effective HEC mitigation. One major disconnect has to be overcome to harmonize wildlife management issues like HEC. This is between local, more consensual decisions that can be made by consultation and negotiation at the conflict zone level, and fixed policies and hierarchical government

decisions outside the conflict zone (Hoare, 2007). The concept of a vertical integration model (VIM) tries to make this process happen.

The AfESG employed a consultant to evaluate the application of a VIM in established government structures in two countries—Mozambique and Tanzania—a good case study of neighbouring states having very different administrations but also sharing elephant range. The consultant's report states that even without formal national coordination, pilot areas with NGO-backed projects that have made local, multiple and low-tech HEC mitigation approaches (like the chilli package combined with some village land-use planning) have already significantly reduced HEC (AfESG, 2010). The report advocates more devolution of centralized authority to community-based natural resource management (CBNRM) to 'resolve lags and address inertia in natural resource governance'.

In local workshops the emerging political climate in rural Africa shows there is growing support for a simple cost–benefit equation: local management of HEC and PAC as long as it is part of CBNRM that can bring benefits (Garnier, 2006; Mpanduji and Malima, 2006). Such devolution initiatives reduce the reliance on PAC by central government agencies, thereby also slowing the wasteful and ineffective practice of routine killing of problem elephants.

The mechanisms by which a VIM can be achieved are proposed at local, national and even international level (Table 1). A strongly advocated activity is bringing together stakeholders in a forum that can share information, build collaboration and advocate new policies. Such forums can be at different levels and have already been effective in both Mozambique and Tanzania in other sectors such as forestry and land rights (AfESG, 2010). A HEC forum also includes the essential ingredient of strengthening often poor horizontal linkages (e.g. by focusing contact and negotiation among wildlife, agricultural and land-use planning authorities within governments).

Conclusion

The amount that has been learned to date about HEC could never have been imagined 15 years ago, and remarkable progress has been made in mitigation in that span of time. Researchers and managers across Africa have risen to the challenge and largely recorded their experiences in an extensive body of freely available literature of all kinds. There are myriad human–wildlife conflict (HWC) studies in conflict zones, some national summaries and strategies (e.g. Anderson & Pariela, 2005; Dunham et al., 2010), several manuals for field practitioners (e.g. Hoare, 2001b; Osborn & Parker, 2002b; Parker et al., 2007a) a plethora of meeting proceedings by NGOs (e.g. Hill et al., 2002; FFI, 2007) and a few continental overviews (e.g. FAO, 2009), often involving multiple problem animal species. All this now represents a solid research foundation.

Effective HEC and HWC mitigation is difficult to understand and problematic to implement because it remains a complex package of apparently disparate measures that have to be used in combination and flexibly, at different temporal and spatial scales. For administrators to grasp this concept without exposure to the problem in practice is difficult: indeed, almost counter-intuitive. As much as it is possible to summarize semi-diagrammatically, the whole process is illustrated in a poster (fig. 3).

We are now at something of a crossroads because the most urgent and crucial part of containing the problem across the continent is to implement socio-political measures to address HEC by improved

Table 1. Main activities in a vertical integration model for HEC mitigation

Locale/site level	Pilot community-based conflict mitigation initiatives – sites with a matrix of situations
Region or district level	1. Regional HEC Forums 2. District HEC and land-use planning committees 3. HEC training programmes for data collection and mitigation
National level	1. National forum for HEC mitigation 2. National Elephant Management Plan 3. HEC data and research collation
Africa level	IUCN support via AfESG

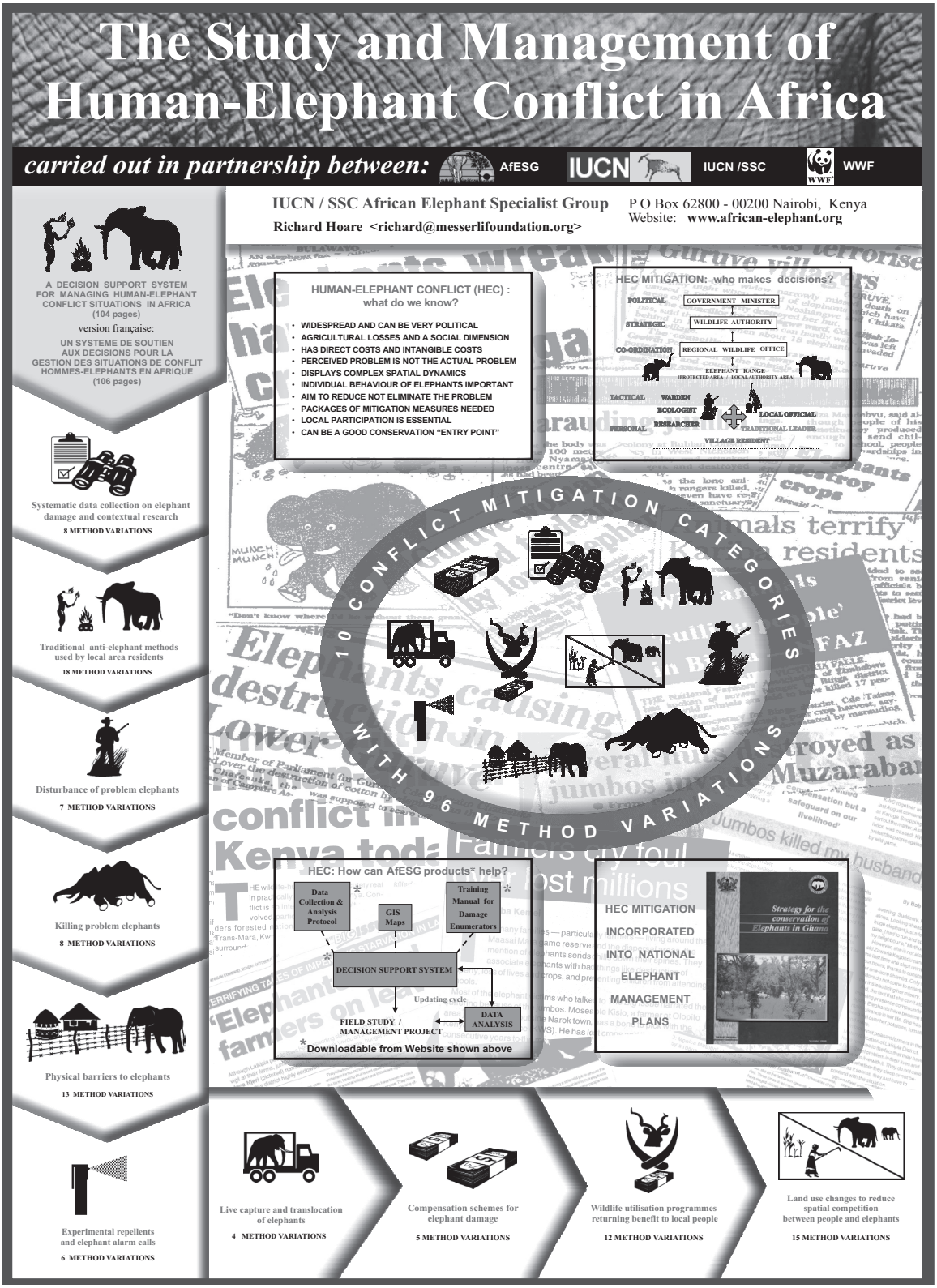

Figure 3. A poster summary depicting the AfESG's systematic approach to HEC mitigation and its incorporation into national elephant management plans.

governance. Thus, future HEC mitigation will be as much an art as it has been a science. The common psychology of human–wildlife conflict across taxa and countries is reflected in a quote about lions that applies equally to elephants: 'large carnivore management is as much a political challenge as a scientific one' (Treves & Karanth, 2003). Virtually all sectors of society support initiatives to resolve human–wildlife conflict in principle, but in practice real progress in improved governance can be very slow and difficult. However, from the perspective of providing sound technical advice on HEC and HWC, we can at least now contribute to such efforts with reasonable confidence, due to a good foundation of knowledge.

Acknowledgements

I would like to sincerely thank the AfESG for their long-term commitment and support to HEC work over many years. Particular thanks are due to the chair Holly Dublin and a succession of programme officers: Ruth Chunge, Greg Overton, Leo Niskanen, Julian Fennessy and Diane Skinner. Database manager Julian Blanc also gave useful assistance. Via their valuable cooperation in practical work the following consultants gave especially strong contributions to the review: Loki Osborn, Guy Parker, Noah Sitati, Matt Walpole, Lucas Malugu and Simon Anstey.

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