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Comparing biodiversity offset calculation methods with a case study in Uzbekistan

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ABSTRACT

Biodiversity offsets are interventions that compensate for ecological losses caused by economic development, seeking 'no net loss' (NNL) of biodiversity overall. Calculating the ecological gains required to achieve NNL is non-trivial, with various methodologies available. To date, there has been no comparison among methodologies for a common case study. We use data on industrial impacts in Uzbekistan to provide such a comparison.

We quantify losses from 40 years of gas extraction, using empirical data on vegetation impacts alongside estimates of disruption to mammals. In doing so, we implement a novel technique by estimating spatial 'functional forms' of disturbance to calculate biodiversity impacts. We then use a range of offset methodologies to calculate the gains required to achieve NNL. This allows a crude comparison of the potential biodiversity outcomes of "in kind" offsets (here, vegetation restoration) with "out of kind" offsets (protecting fauna from poaching).

We demonstrate that different methods for calculating the required offset activities result in divergent outcomes for biodiversity (expressed in habitat condition x area, or 'weighted area'), and different trajectories in biodiversity outcomes over time. An Australian method is currently being considered for adoption in Uzbekistan, but we show that it would require careful adjustments to achieve NNL there.

These findings highlight that the method used to quantify losses and gains strongly influences the biodiversity outcomes of offsetting, implying that offsets generated using different methodologies are not transferable between jurisdictions. Further, conservation gains from out of kind offsets may outweigh those from strict in kind NNL interpretations.

1. Introduction

Biodiversity offsets ('offsets') are a mechanism by which industry can compensate for unavoidable ecological losses associated with development (Madsen et al., 2011). Offsets are implemented through both regulatory and voluntary schemes (Doswald et al., 2012). The essential objective of most offset policies is 'no net loss' (NNL) of biodiversity alongside economic development (BBOP, 2012; Bull et al., 2013a); accepting local losses at the sites of activity but compensating for these by producing equivalent biodiversity gains elsewhere. Offsets should generally be implemented as part of a mitigation hierarchy, such that negative impacts are first avoided and minimised where possible (Gardner et al., 2013). A challenge to effective offsetting, having quantified the residual biodiversity losses associated with development, is the calculation of the biodiversity gains required to deliver NNL (Quétier and Lavorel, 2011; Bull et al., 2013a). Losses and gains are separated in space and time, and potentially differ in biodiversity type; hence there is a need for a common measure of ecological equivalence to compare them.

The term "offset" encompasses a range of approaches to comprehensive (NNL) biodiversity compensation, from habitat-specific calculations to generalisable frameworks (Madsen et al., 2011; Doswald et al., 2012). Several different methodologies exist for calculating the gains required to compensate any given development project: some use area as a proxy for habitat losses and gains (e.g. King and Price, 2004, suggest that many US Wetland Banking offsets effectively use an area-based approach); some use a combination of area and 'functionality' of the habitat (e.g. Canadian Fish Habitat);

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others combine area and ‘condition’ and compare this against some benchmark pristine state (e.g. Australian vegetation offsets); and some focus on species, calculating the area of habitat necessary to support a given population (e.g. US Conservation Banking; McKenney and Kiesecker, 2010; Quétier and Lavorel, 2011). Recent developments include a pilot UK policy (Defra, 2011), and a South African policy which incorporates consideration of ecosystem services (Brownlie and Botha, 2009). Some methodologies were developed for specific circumstances, such as those governing native grassland clearances in Victoria, Australia; others, such as US Wetland Banking, are intended as general frameworks.

Despite the underlying NNL objective, it is not clear how such methodologies compare to one another in terms of biodiversity outcomes, when applied to a common case study. Here, we fill this gap, whilst providing a basis for exploring the extent to which different offset methodologies interpret and achieve NNL. Such a comparison is important to highlight to what degree different methodologies are designed within specific jurisdictional contexts, and for different conservation priorities: a point perhaps not always recognized by those designing polices, who might rely heavily upon existing methodologies developed elsewhere when designing their own. The work can also provide insight into how far national offset policies concur on the ecological requirements for NNL, contributing to debate upon whether international offset trades are possible, e.g. trading impacts in one country for offsets in another.

1.1. Objective of biodiversity offsets

Whilst offsets ostensibly seek NNL overall, each approach inevitably focuses upon specific sub-components of biodiversity as proxies for total biodiversity (Bull et al., 2013a) – biodiversity being ‘‘the sum total of all biotic variation from the level of genes to ecosystems’’ (Purvis and Hector, 2000). Offsets can rely upon *habitat-based*, *species-based*, or other calculation methods: respectively, whether offsets focus on vegetation assemblages, focus upon particular species (usually fauna), or consider alternatives such as ecosystem services (Quétier and Lavorel, 2011). We group a set of ecological compensation measures – not all true biodiversity offsets, but which require NNL – into those which are habitat-based or species-based. We do not consider ecosystem service offsets here as, which have yet to become established.

Habitat-based approaches generally rely on measures of area and habitat ‘condition’ to calculate losses and gains (BBOP, 2012). Victorian native grassland compensation in Australia uses ‘habitat hectares’, based upon the method outlined by Parkes et al. (2003). Biodiversity losses and gains are compared to a ‘pristine’ reference state, and measured in hectares multiplied by condition, the latter based upon criteria including vegetative recruitment and presence of invasive weeds. A variant on this approach is being trialed in the UK (Defra, 2011).

Species-based approaches also tend towards calculation methods based upon the spatial extent and quality of biodiversity losses or gains, but instead of condition rely upon some measure of the suitability of habitat for the target species. US Conservation Banking takes this approach for a suite of protected species (US FWS, 2006), as does the EU under the Birds and Habitats Directives (McKenney and Kiesecker, 2010).

A critical consideration is that offset policies do not always restrict biodiversity trades to being ‘in kind’. Whilst trading in kind is encouraged (BBOP, 2012), it has been argued that conservation objectives could sometimes be better served by trading ‘out of kind’ (Habib et al., 2013). Some policies allow e.g. trading of losses in low value conservation areas for gains in high value areas (e.g. Defra, 2011) or even encourage it (e.g. Brownlie and Botha, 2009); or allow for trading losses in the habitat of one species for gains in that of another (e.g. US Conservation Banking). The extent to which out of kind offsets are acceptable, and how to coordinate this at a landscape scale, are currently open questions.

1.2. Testing methodological approaches against a common case study

Offsets have been proposed as a means to compensate for the biodiversity impacts of the oil and gas (O&G) sector upon the Ustyurt plateau, Uzbekistan (Bull et al., 2013b). We use the Ustyurt as a comparative case study, exploring the offset requirements that could have been imposed for O&G infrastructure developed over the last 40 years under a range of methodologies. These insights can be used to inform a biodiversity offsetting project led by the United Nations Development Program – although we do not aim here to advise on the most appropriate methodology for the Ustyurt, a decision which would require consideration of other issues beyond the scope of our study. The research is timely because, at a global scale, many countries (including Uzbekistan, but also e.g. the UK) are developing regulatory frameworks for offsetting.

The Ustyurt plateau (44°N, 57°E) is shared between Uzbekistan and Kazakhstan, west of the Aral Sea. Approximately 100,000 km^2 of the plateau is within Uzbekistan. It is semi-arid and dominated by *Artemisia*, *Anabasis* and *Halyoxylon*, and home to fauna including the Critically Endangered saiga antelope *Saiga tatarica*. There are four small settlements on the plateau, a railway and gas pipelines, and increasing natural gas exploration and extraction activity. Habitat clearance and disturbance to threatened fauna are material ecological impacts of the O&G industry (UNDP, 2010).

Vegetation clearance due to O&G activity has been quantified (Jones et al., 2014), allowing the application of habitat-based offset calculation methodologies. For species-based methodologies, the flagship species is the saiga antelope (UNDP, 2010). This nomadic ungulate previously occurred in large numbers throughout the region, and was the only abundant large herbivore in the ecosystem (Bekenov et al., 1998), potentially having a substantial role in structuring vegetation communities. Saigas have declined by >90% in the region since the early 1990s as a result of poaching (Kühl et al., 2009), making them a conservation priority for Uzbekistan. Human presence and infrastructure have behavioral impacts upon saigas, modifying their use of habitat (Singh et al., 2010; Salemgareev, 2013), but there are no data on these impacts for the Uzbek Ustyurt, and no suggestion that poaching is directly attributable to the O&G industry. To estimate potential disturbance to saigas from O&G infrastructure, thereby developing a species-based calculation method, we use estimates from a meta-analysis into the influence of human disturbance upon mammals.

2. Materials and methods

2.1. Implementing the principles of biodiversity offsetting for the case study

Offset projects require the creation of additional biodiversity value, so those hypothetically implemented in our calculations needed to raise the condition of degraded land in the Ustyurt. More generally, it is possible in deteriorating landscapes to implement offset projects that prevent biodiversity losses that would otherwise have occurred i.e. ‘averted loss’ offsets (Gordon et al., 2011; Bull et al., 2014). The Ustyurt habitat has deteriorated in recent decades as a result of the Aral Sea crisis (Micklin, 2007). However, to concentrate on the comparative study of different metrics, we simplify by treating the habitat as stable.

In practice, habitat-based offsets might involve managed habitat restoration, such as reseeding areas in which vegetation had been cleared. For species-based offsets, activities might include