Utilitarian framings of biodiversity shape environmental impact assessment in development cooperation

Supplementary material

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Tables

Table 1: Schematic overview of key descriptors of ideal-typical biodiversity framings derived from the scientific literature (adapted from Holmes et al., 2011; Mace, 2014; Miller et al., 2011; Tallis & Lubchenco, 2014)

Biodiversity framings	**Key descriptors**	**Source**
Nature for itself	Species; Wilderness; Protected Areas;	Mace (2014)
Nature despite people	Extinction threats, threatened species; Habitat loss; Pollution; Overexploitation;	Mace (2014)
Nature for people	Ecosystems; Ecosystem services; Economic values;	Mace (2014)
People and nature	Environmental Change; Resilience; Adaptability; Socio-ecological systems;	Mace (2014)
Nature protectionists	Protected Areas (PAs); Limiting human presence & disturbance; Biodiversity protection as primary goal;	Miller et al. (2011)

Social conservationists	Sustainable use; Development and welfare-oriented goals; Poverty alleviation and social justice;	Miller et al. (2011)
Traditional conservation 2.0	Biocentric motivation; Conserving ecosystem processes; Biodiversity in pristine areas and in modified landscapes;	Holmes et al. (2016)
Nearly new conservation	Market-based instruments; Science should play a strong role; Avoid harm to people when protecting biodiversity;	Holmes et al. (2016)
Market skepticism	Benefits for people are key; Opposes links with capitalism and corporations;	Holmes et al. (2016)
Intrinsic value of nature	Protect nature for its own sake;	Tallis & Lubchenco (2014)
Instrumental value of nature	Protect nature to help ourselves;	Tallis & Lubchenco (2014)

Table 2. Biodiversity-relevant characteristics of the analysed EIAs *(Authors Note: Could also be provided as Supplementary Material)*

EIA Number/ country	Topic of the project on which EIA was applied	Considered biodiversity aspects in the EIA	Quality and level of detail of baseline data in the EIA	Use of baseline data in the EIA environmental management plan (EMP)

EIA 1 / Benin	Paving of the access road to a landfill site	• Negative impacts: potential destruction of trees; • Fish 'resources' separated from other fauna in impact assessment; • Temporary increase of water turbidity could affect fish resources;	• Vegetation: plantations species identified; • Common birds: species or family level; • General names for fauna (scavengers, birds, rodents, insects); • Aquatic fauna: species-level ; • Land use map with 4 vegetation categories (thickets, plantations, crops and fallows);	• Limited explicit linkages between baseline & EMP; • Uprooting of trees identified (acacia and teak), only *Acacia* mentioned in the baseline & EMP; • Reforestation as mitigation measure, with no information about the type of tree (except in teak and acacia areas) • Installation proposed far from a lake to avoid contamination, without reference to any biological data; • No biological data in the EMP;
EIA 2 / Burkina Faso	Extension of thermal power stations	• Negative impacts: plant cover reduction, fragmentation and destruction of fauna habitats (with no specification); • Number of trees to be cut identified (% of vegetation cover loss quantified); • No information about fauna;	• Ecosystem types cited; • Mention of existing (non-project related) threats to vegetation; • Qualitative presence of some plant species; • Reference to the presence of plants that are useful for humans (no specifications); • No reference to fauna • Floristic inventory (as appendix, not available) includes sanitary state of trees;	• Reforestation as mitigation measure, with no information about the type of tree (only mention that it will be a mix of local and exotic species); • No biological data in the EMP;
EIA 3 / Ivory Coast	Widening and asphalting of roads	• Mammals threatened by poaching, agriculture, bushfire;	• Qualitative description of vegetation types, forest	• EMP assumes that there is no flora or fauna of ecological

		• Plant species impossible to determine in sacred forests; • Negative impacts: landscape alteration and degradation of plant cover; however: No significant impact on biological components as project in urbanized area; • Vegetation considered for its role against erosion and mitigation (replant trees with deep root systems);	categories and presence of sacred forests; • Mention of existing (non-project related) threats to mammals in the region: poaching, agriculture, bushfire; • Common name of most and least common mammals and birds, with reference to endemism; • Qualitative presence of groups ('amphibians', 'insects', 'reptiles'); • Mention of domestic animals presence in the area;	interest in the area (unspecified in baseline); • Landscape design often cited in EMPS, never in the baseline; • Vegetation monitoring is part of the EMP;
EIA 4 / Ivory Coast	Gas field expansion	• Reference to the complexity of marine food chains • Negative impacts: imbalance of the marine ecosystem, habitat disturbance, contamination, damage to fish;	Based on field studies: • Phytoplankton: (taxa vary from species-level to class-level, number/m^3) + seasonality • Benthic community: trophic categories, species assemblages, number of species for each ecological zone • Fish: communities (incl. dominant species), habitat, seasonality • Birds: list of important and migratory species • Marine mammals + marine turtles : species, habitat, threats • Ecosystems: forest types with dominant species;	• Explicit linkages (contamination risks mentioned in both baseline and EMP (e.g. mangrove fringes, coastal lagoons)); • Monitoring of marine mammals and marine turtles included in the EMP;

			• Flora: number of woody species, list of endemic species • Mammals and reptiles : species-level • National parks : description with important ecosystems/species • Threatened species	
EIA 5 / Ivory Coast	Obsolete Pesticides Management	• Negative impacts : loss of plant cover, loss of habitats contamination of fauna and flora if leaks; • Microphytes as important source of primary production for living matter usable for humans; • Floating hydrophytes as plague; • Decapods as resource for fishing and for their role in the ecosystem; • Preservation of natural resources as positive impact of pesticide decontamination;	• Vegetation: type, area, pressure, dominant species, land cover map; • Qualitative presence of Macrophytes, phytobenthos, phyto-and zooplankton, crustaceans, birds, crocodiles - macrofauna at various levels (class to species-level); • Quantitative information only for fish, zooplankton, and extent of forests and national parks; • Interactions between species (crustaceans as food for fish) • Conservation status and endemism for a few species;	• No biological data in EMP; • Reforestation as mitigation measure against the loss of plant cover and habitats of high biodiversity value, with no information about the type of tree;
EIA 6/ Ghana	Oil field development	• List of species of fisheries interest; • Mention of dependencies or impacts of activities on ecosystem services (very detailed); • Negative impacts: loss & fragmentation of habitat, impacts on flora due to	• Very detailed baseline study based on field surveys with quantitative data, conservation status, habitat, seasonality, and species-level for most taxa, at project level (areas of influence) • 31 ecosystem services identified for each habitat type;	• Strong linkages between baseline data & EMP; • Monitoring Programs for fish & marine turtles included; • EMP includes sub-plans for marine fauna, vegetation and alien species, biodiversity and ecosystem services;

		degradation of abiotic components of ecosystems, introduction of alien species, disturbance and/or displacement of fauna due to pollution, increased mortality of wildlife, impacts on landscape, disturbance of marine fauna due to physical disturbance of seabed, etc.;		• Biodiversity management plan includes: transplantation of important species, forbidding collection of specimens, , avoidance, management, monitoring, repair and remediate; • Mitigation options mentioned for each ecosystem service affected;
EIA 7 / Liberia	Electricity expansion project	• No reference to a biological component in impact assessment; • Only biodiversity impact identified: sediment-laden storm water runoff can negatively impact aquatic flora and fauna;	• Qualitative presence of most common species for flora (9 cited) and fauna (mammals, birds, reptiles); • Conservation status; • Growth form, dominance and invasiveness information for plants; • National parks and Ramsar wetlands described at national level (none in the influence area of the project);	• No reference to biological data in the EMP: (quote: '*The pipeline exists in an industrial area away from any natural context'*);
EIA 8 / Mali	Obsolete pesticides management	• Fauna and flora assessed as affected environmental components of 'High' importance; • Positive and negative impacts identified only in general terms: ('*Activities will have a negative impact on soil, vegetation'*)	• At national scale: number of species of mammals, birds and fish; • Only for high-risk sites: very general mention of presence of domestic animals, flora (e.g. '*Some bushes and tall grass surround the site'*) and fauna (e.g. '*presence of birds and rodents*')	• Weak link: only reference to general terms 'fauna 'and 'vegetation' in EMP;

		• Threats identified on biodiversity at national level;		
EIA 9 / Mauritania	Offshore gas field development, incl. production wells, subsea pipeline and onshore gas processing facilities;	• Differentiation between local and regional area of influence of the project • Fish data (cf. baseline info) include information on fisheries (e.g. fleet, fish landings); • Seabed, marine ecology and terrestrial ecology are considered; • Negative impacts: noise disturbance to marine mammals; placement of subsea infrastructure may lead to impact to seabed and benthic fauna; occasional oil spills may cause impact to marine habitats and species;	• Detailed & systematic biodiversity survey incl. reference to use of IUCN, FAO & *FishBase* data; • Data on geographical distribution of primary productivity at sea; • Species-level info for plankton, benthic Annelida, marine mammals, sea turtles (incl. maps), birds (incl. seasonality), reptiles & mammals; • Reference to IUCN conservation status of selected species; • Terrestrial biodiversity survey includes land cover types and info on ongoing reforestation project; • Mention of protected areas locations;	• Limited linkage between baseline and EMP; • Pre- and post-installation survey and micro-routing of the pipeline to avoid sensitive habitats; • Careful site layout plus offsetting of vegetation loss, based on mapping of vegetation in baseline study;
EIA 10 / Niger	Irrigation project in arid region	• Wild fauna as protein source (hunting); • Fauna as threat to people (jackals); • Negative (vegetation removal) and positive (regrowth downstream) impacts of	• No quantitative baseline data; fragmentary qualitative data on presence of macrofauna (mammals, birds); • Species-level data for trees, including references to national conservation status;	• No explicit linkages; • Hunting ban during construction phase linked to identified general poaching threat;

		irrigation infrastructure mentioned;	• Mention of existing (non-project related) threats to fauna in the region: poaching, encroachment;	
EIA 11 / Nigeria	Bridge construction in National Park	• Soil microorganisms sampled because of their role in soil carbon storage; • Focus on iconic species: primates, limited mention of other mammals and birds; • Focus on improved national park management & conservation enforcement: through improved access; • Yet increased accessibility leads to increased human movement and hence increased illegal hunting cutting & encroachment by farmers;	• Fauna studies & vegetation studies mentioned, based on literature review and interviews; • Species-level presence data for primates only, incl. conservation status; • Limited presence list of selected other taxa (birds, mammals);	• In the EMP: mention of demarcation between forest farming and preserved area; • Potential loss of fauna during construction phase linked to conservation status of some species;
EIA 12 / Nigeria	Building rice processing centre & access roads	• Cumulative negative impacts include: deforestation due to agricultural development; • Negative impacts of access road: biodiversity reduction, habitat destruction, impending of wildlife movement, increase in poaching and illegal removal of firewood;	• Qualitative ecosystem description; • List of economically important crop species; • Incomplete presence lists of mammals, birds and reptiles provided, with qualitative indications of degree of rarity;	• Set-up of vegetation clearing and biomass management plan linked to predicted biodiversity loss (qualitative);

		• Eutrophication and destruction of local ecological functionalities due to agriculture; • Proposal of actions to decrease demand for bushmeat; • Proposed collaboration with conservation groups;		
EIA 13 / Nigeria	Power plant & gas pipeline	• Basic information on the use and functions of mangroves (not site-specific); • Mention of importance of ecosystem for local communities' livelihoods; • Negative impacts on freshwater ecology rated very high as it is a breeding ground for fish, amphibians etc.; • Excavation of the pipeline trench is expected to disperse sediments which may smother benthic invertebrates; • Heavy metals released through sediment movement could bio-accumulate in the food chain; • Destruction of bird nests is expected impact; • Underwater noise may disturb marine mammals;	• Info on floristic composition and forest types, including standard comment on conservation status ('*there are no unique, rare or endangered species*'); • Genus-level information regarding invertebrates; • Low resolution of baseline data on e.g. birds where category such as 'songbirds' is used;	• Link between baseline section and EMP limited; • Mitigation measures include adapted drilling technique to avoid sediment damage; timing of construction work outside of main breeding season of birds; • Use of least intrusive dredging equipment and dredging during low tide when feasible, is advised;

		• Mitigation includes the prohibition of hunting & selling of bushmeat & avoidance of fauna migration paths;		
EIA 14 / Nigeria	Rehabilitation of an irrigation scheme	• Ponds and game reserves cited as tourist sites; • Vegetation in the baseline study associated to its local uses; • Fish as animal protein in baseline; • Negative impacts: increased de-vegetation, and loss of economically interesting plants and animals; discharge of sediment laden run-off and contaminants in water runoff may affect aquatic life; • Biodiversity aspects as a negative social impact (attack from dangerous animals during de-vegetation activities , increase of crop production thereby attracting higher density of pests, Increased presence of termite mounds, nematodes, Bat infestation, *Typha* grass invasion, *Quelea quela*	*At state level:* • Short qualitative description of vegetation, and number of domestic animals • Sites of significance interest (tourist places): national parks, ponds • Ecological problems include desertification, and environmental degradation (fuel wood); *At project level:* • Species lists based on field survey for plant species, • aquatic plant species, fauna (only some mammals, birds, bats, termites, fishes) • Information on local uses of plant species • Quantitative data on increase/decrease of fish catch (%) • Qualitative summary of habitats types • Damages caused by termites	• No explicit linkage between baseline section and EMP; • Revegetation of cleared areas planned with beneficial local species known to mitigate against erosion • Clearing should avoid areas with indigenous vegetation • Training against attack from dangerous animals during de-vegetation activities as mitigation: • Anti-birds sprays, insecticides, rodenticides and physical disturbance of bats and birds as mitigation;

		invasion, grasshoppers invasion);		
EIA 15 / Nigeria	• Gas turbine power plant	• Minor negative impacts: disturbance & loss of wildlife considered minor; • Moderate negative impact: loss of vegetation & disturbance and loss of benthic organisms t; • Prohibit hunting & selling of bushmeat, train in fauna avoidance & migration paths • In mitigation section: restore & revegetate, control invasive plants, design access roads to minimize destruction and fragmentation	• Vegetation & wildlife & marine ecology (plankton, benthic macroinvertebrates, fisheries); • Details on p. 19 (habitats & vegetation) with focus on plants with edible fruits; • Species-level presence info on limited list of 35 animals based on interviews, tracks & fecal analysis; • Species-level info on plankton & fish, both in wet and dry season; • Vegetation survey, incl. vegetation type and distribution map; • Species-level flora info, including use; • Conservation status listed for selected mammal species;	• Limited linkages between baseline data & EMP; • Habitat disturbance estimate is provided (% of area disturbed per vegetation type & location) in the EMP;
EIA 16 / Nigeria	Urban water supply & sanitation project	• Focus on domestic species only; • Soil & water analysis is detailed; • Biodiversity defined as 'terrestrial habitats' in the impact matrix; • Mention of increasing human population that may lead to biodiversity loss;	• Vegetation assessment done only on cultivated fields (as the site is heavily urbanized); • Species-level fauna info limited: presence list of domestic animals and crops;	• No explicit linkages between baseline data & EMP;

EIA 17 / Senegal	Road rehabilitation project	• Ecosystem services framework is presented; • Mention of biodiversity linked to national policy (National Biodiversity Strategy & Action Plan); • Mitigation strategies include hunting & firewood collection bans during construction phase;	• Indicative number of plant and bird species, compared to nationally present species totals; • Species-level presence info for four mammals; • Species-level presence info for vegetation, including conservation status according to National Forestry Law; • Mention of nearby Marine Protected Area (MPA);	• No explicit linkages between baseline data & EMP, although mention of avoiding vegetation loss;
EIA 18 / Senegal	Development of sewage system	○ Biodiversity mentions linked to National Biodiversity Action Plan and to National Environmental Law; Differentiated impacts with or without mitigation plans ('variance analysis') on fauna described; Flora: negative impact on photosynthesis due to dust during construction work; Impacts of the emission of wastewater in the lagoon is considered problematic for two reasons: crustacean populations (including nursery function of mangroves) & bathing water will be impacted	• Species & genus-level presence data for Mollusca; • Species-level presence data for mangrove trees; • Vernacular names only for birds; • Focus on MPAs information;	• Based on the biodiversity in the lagoon, abandoning the emission of wastewater in lagoon is proposed; • Mitigation actions for the prevention of pollution of the marine protected area are listed;

Table 3. Consideration of biodiversity in the assessed EIAs along three dimensions of the conceptual framework outlined in Section 2. Table 3 is an interpretative synthesis of Table 2. Framings terminology is based on Holmes et al. (2016), Mace (2014), Miller et al. (2011), Tallis & Lubchenco (2014) as outlined in Table 1. Regarding decision-making context: the symbols refer to the links between the baseline data and the environmental management plan ('-': no link; '+': link; '++': strong link)

EIA number	Biodiversity framing	Representation of biodiversity	Decision-making context
EIA 1	• *Intrinsic value / Nature for itself:* species; • *Instrumental Value / Nature for people / Social conservationist:* ecosystem services (sacred forest, fish resources separated from fauna in impact identification);	• Qualitative presence data • Species-level (only for plantations, fishes, crustaceans, molluscs, birds)	+
EIA 2	• *Intrinsic Value / Nature for itself:* species, habitats); • *Nature despite people / Nature protectionist / Traditional Conservation:* habitat loss and overexploitation (threats on plants: agriculture, livestock, timber, firewood) • *Nature for people / Nearly New Conservation / Instrumental Value:* ecosystem services (plants useful for humans)	• Species-level for some plants • Type of ecosystems present	-

EIA 3	• *Intrinsic Value / Nature for itself*: species • *Nature despite people / Nature protectionist:* habitat loss and overexploitation (threats on mammals: agriculture, bushfire, poaching) • *Nature for people / Instrumental Value:* ecosystem services (domestic species, sacred forests, plant cover against soil erosion)	• Species-level and endemism for birds • Common names for mammals • General names for other groups ('reptiles', 'amphibians' and 'insects') • Vegetation types and forest categories	-
EIA 4	• *Nature for itself / Intrinsic Value*: species, protected areas (habitats, ecology) • *Instrumental Value / Nature for people:* ecosystems • *Nature protectionist / Nature despite people:* overexploitation (threats on marine turtles)	• Species-level • Quantitative data for plankton, benthos, flora • Habitat information • Seasonality included • Conservation status • Endemism information • Interactions between species (food chain)	++
EIA 5	• *Intrinsic value / Nature for itself*: species, protected areas • *Nature protectionist / Nature despite people*:	• Species-level presence for variety of taxa • Quantitative information only for fishes, zooplankton,	-

	overexploitation and habitat loss (agriculture, bushfire, hunt) • *Instrumental Value / Nature for people / Nearly New Conservation*: ecosystem services (food resource, photosynthesis);	and extent of forests and national parks • Conservation status and endemism (qualitative)	
EIA 6	• *Nature for itself / Intrinsic Value*: species, protected areas • *Nature protectionist / Nature despite people*: threats, threatened species, habitat loss, pollution and overexploitation • *Instrumental Value / Nature for people*: ecosystems, ecosystem services (considered as receptor of impact and included in EMP)	• Species-level • Conservation status • Seasonality • Migration information • Quantitative data for all taxa • Species of fisheries interest • Ecosystem services (31) for each habitat	++
EIA 7	• *Intrinsic Value / Nature for itself*: species, protected areas • *Nature protectionist / Nature despite people*: threats, threatened species, pollution, overexploitation (mining, firewood, charcoal, fishing)	• Qualitative presence data • Species-level • Conservation status • Endemism of plants	-

EIA 8	• *Intrinsic Value / Nature for itself*: species, protected areas • *Nature protectionist / Nature despite people*: habitat loss and overexploitation (logging, overgrazing, poaching, fishing, bushfire, chemicals, climate change), pollution (chemicals for pest control) • *Nature for the people/Instrumental value*: ecosystem services (domestic animals and crops)	• General descriptors used ('trees, bushes, birds') • Number of species of mammals, birds and fishes (national scale only)	-
EIA 9	• *Nature protectionist / Nature despite people*: overexploitation (hunting), habitat loss (vegetation loss, fragmentation) • *Instrumental value / Nature for the people*: ecosystem services (edible fruit crops)	• Ecosystems information (marine) • Species level data for plankton, fish, birds, mammals • Seasonality included • Conservation status	+
EIA 10	• *Nature protectionist / Nature despite people*: overexploitation (poaching), habitat loss (encroachment); • *Instrumental Value / Nature for the people*: ecosystem services (protein source);	• Qualitative presence data • Species-level info only for trees • Conservation status	-

EIA 11	• *Nature Protectionist / Nature for itself*: protected area (national park conservation enforcement) • *Nature protectionist / Nature despite people*: overexploitation (poaching), habitat loss (encroachment) • *Instrumental value / Nature for the people*: ecosystem services (carbon storage)	• Species level presence data for primates • Conservation status	+
EIA 12	• *Nature protectionist / Nature despite people*: threats (wildlife), habitat loss & overexploitation • *Instrumental value / Nature for the people*: ecosystem services (economically important crops)	• Ecosystems information • Qualitative data on mammals, birds, reptiles • Conservation status (qualitative)	+
EIA 13	• *Intrinsic value / Nature for itself*: protected areas, species • *Social conservationists / People and nature*: socio-ecological interactions (food chain bio-accumulation)	• Ecosystems information • Genus-level data on invertebrates • General descriptions birds • Conservation status	+
EIA 14	• *Intrinsic Value / Nature for itself*: species, habitats	• Species–level for plant species, aquatic plant	+

	• *Nature protectionist / Nature despite people*: overexploitation, pollution, habitat loss • *Instrumental value / Nature for people / Social conservationists*: ecosystem services (protection against erosion, food, tourism)	species, fauna (only some mammals, birds, bats, termites, fishes) • Local uses of plant species • Quantitative data on trends in fish catch • Qualitative summary of habitats types	
EIA 15	• *Intrinsic value / Nature for itself*: species, protected areas • *Instrumental Value / Nature for the people*: ecosystem services (fisheries)	• Ecosystems information (marine & terrestrial) • Extensive referencing to biodiversity databases • Species level data for variety of taxa • Conservation status	+
EIA 16	• *Intrinsic Value / Nature for itself*: species, protected areas • *Instrumental Value / Nature for the people*: ecosystem services (fisheries)	• Ecosystems information (marine & terrestrial) • Extensive referencing to biodiversity databases • Species level data for variety of taxa • Conservation status	-

EIA 17	• *Instrumental value / Social Conservationists / Nature for the people*: ecosystem services (framework presented as guide)	• Species level data for selected taxa	-
EIA 18	• *Nature protectionist / Nature despite people / Traditional conservation*: overexploitation, pollution, habitat loss • *Intrinsic Value / Nature for itself*: species, protected areas • *Instrumental Value / Nature for the people*: ecosystem services (food, clean water, recreation)	• Species and genus level data selected taxa • Species level data trees • Conservation: focus on Marine Protected Area	+