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Mainstreaming Biodiversity in Development Cooperation Projects through the Application of Mitigation Hierarchy and Green Infrastructure Approaches

Tetsuya Kamijo*

Abstract

The importance of biodiversity to human welfare is widely recognized and environmental impact assessment (EIA) is regarded as a useful tool to minimize adverse impacts on biodiversity due to development. However, biodiversity loss continues in particular in developing countries though biodiversity-inclusive assessment has been implemented for a long time. The purpose of this working paper is to propose a practical approach for mainstreaming biodiversity into development cooperation projects. This paper examines the biodiversity mitigation measures of 120 EIA reports prepared by the Japan International Cooperation Agency from 2001 to 2012 using quantitative text analysis. The present biodiversity considerations are inadequately addressed and the avoidance measures are quite scarce. Ecosystems have multiple benefits and it is worthwhile to incorporate their benefits into development cooperation projects. The application of mitigation hierarchy aiming for no net loss and green infrastructure approaches to make wise use of ecosystem services can be one solution to stop biodiversity loss and satisfy development needs.

Keywords: biodiversity, ecosystem services, mitigation hierarchy, green infrastructure, ecosystem-based disaster risk reduction

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Introduction

Biodiversity refers to the variety of life on earth at all its levels, from genes to ecosystems (CBD 2006, p. 13) and is described as ‘a life insurance of life itself’ (CBD 2005, p. 34). Environmental impact assessment (EIA) is the process of identifying, predicting, evaluating, and mitigating the biophysical, social, and other relevant effects of proposed development proposal prior to major decisions and commitments being made (IAIA 2009). Mainstreaming biodiversity has no single agreed upon definition, though most definitions are quite similar. Parties have an obligation to: ‘integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies’ according to Article 6b of the Convention of Biological Diversity (CBD) (UN 1992a). In September 2004, the Global Environment Facility (GEF) workshop on biodiversity agreed that the objective of mainstreaming biodiversity is to internalize the goals of biodiversity conservation and the sustainable use of biological resources into economic sectors and development models, policies and programmes, and therefore into all human behavior (Peterson and Huntley 2005). A recent definition (Huntley and Redford 2014, p. 14) states, ‘Biodiversity mainstreaming is the process of embedding biodiversity considerations into policies, strategies and practices of key public and private actors that impact or rely on biodiversity, so that biodiversity is conserved, and sustainably used, both locally and globally.’ Mainstreaming biodiversity in this working paper is defined as mitigating the adverse impact on biodiversity due to development cooperation projects, and also making wise use of ecosystem services for achieving the desired development outcomes.

The importance of biodiversity to human welfare is widely recognized (Carpenter et al. 2006; de Groot et al. 2010; Cardinale et al. 2012). In April 2002, the Parties to the CBD committed themselves to achieving a significant reduction in the rate of biodiversity loss by 2010. Achieving the 2010 biodiversity target became a paramount aim of the world’s nations since the adoption of the target by the CBD and the World Summit on Sustainable Development in 2002 (CBD 2002). Yet the Millennium Ecosystem Assessment (MEA) concluded that an unprecedented effort was needed to achieve this target. The loss of genetic diversity, species, and ecosystems is proceeding apace as a result of habitat change, climate change, invasive species, overexploitation of resources, and many forms of pollution (MEA 2005). The CBD prepared the voluntary guidelines on biodiversity-inclusive impact assessment in 2006, which would help to make a direct contribution to the achieving the 2010 target (CBD 2006). Most indicators of the state of biodiversity showed declines, with no significant recent reductions in rate, whereas indicators of pressures on biodiversity showed increases (Butchart et al. 2010; CBD 2010a; Hoffmann et al. 2010). No country achieved the target to significantly reduce the rate of biodiversity loss by 2010 (CBD 2012, p. 3). In response to the above, the CBD has set out the 'Strategic Plan for Biodiversity 2011–2020', whose vision is to value, conserve, and restore biodiversity for the benefit of all people by 2050. The plan has five strategic goals and 20 targets so called 'Aichi Biodiversity Targets', to ensure that by 2020 ecosystems are resilient and continue to provide essential services (CBD 2010b). The Global Biodiversity Outlook 4 (CBD 2014) provides serious indications that the pressures on biodiversity will continue to increase until 2020 while its status would simultaneously decline. Halting global biodiversity loss is central to the CBD and United Nations Sustainable Development Goals (CBD 2010b; UN 2015), but success to date has been very limited (Tittensor et al. 2014; Pimm et al. 2014; Gren et al. 2016; Roque et al. 2018) and biodiversity loss in developing countries has been reported (Pauchard et al. 2006; Butchart et al. 2010; Adenle 2012; Lenzen et al. 2012; WWF 2016). There is urgent need to prioritize biodiversity conservation and management in developing countries (Adenle et al. 2015).

Article 14 of the Convention on Biological Diversity (CBD) provides an explicit mandate for EIA as a tool to minimize adverse impacts on biodiversity due to development (Treweek 2001, p. 14). It requires each contracting party to introduce appropriate procedures requiring EIA of proposed projects that are likely to have significant adverse effects on biological diversity, and to ensure that the environmental consequences of its programs and policies are duly taken into account (UN 1992a). The CBD (2017) reviews the existing guidance documents for the biodiversity-inclusive impact assessment and their extent of application, and finds a narrow focus on biodiversity and limited assessment of ecosystem services in the practice. The CBD invites parties and donors to carry out evaluation studies on the effectiveness of impact assessments to address biodiversity.

This working paper provides an overview of how EIA has mitigated adverse impacts on biodiversity linked to the implementation of development cooperation projects conducted by the Japan International Cooperation Agency (JICA), which assists and supports developing countries as the executing agency of Japan's official development assistance. At the same time, the paper collects useful information for the incorporation of ecosystem services in green infrastructure and in disaster risk reduction, based on a literature review of academic journals, reports from international organizations, and technical books. At the end, the paper proposes a practical approach for improving mainstreaming biodiversity for developing cooperation practitioners.

JICA introduced mandatory EIA guidelines in April 2004 (JICA 2004) and revised them in 2010 to widen the range of the EIA process from the screening stage to the monitoring stage (JICA 2010). The JICA EIA guidelines in 2004 institutionalized procedures for EIA in the preparation phase of the project cycle. These included such things as screening classifying projects into three categories, assessing a wide range of environmental and social impacts, analyzing alternatives including a zero option, and introducing strategic environmental assessment (SEA), information disclosure, and public involvement. The 2004 guidelines explain that plural alternatives should be analyzed to avoid and minimize adverse impacts due to development projects and to recommend preferable options in terms of environmental and social considerations. The hierarchy of mitigation requires measures to be taken to avoid, minimize, and compensate for impacts. The 2004 guidelines resulted in the improved quality of EIA reports (Kamijo and Huang 2016). Donor countries play a catalytic role in the application of the EIA system in developing countries (El-Fadl et al. 2000; Mokhele and Diab 2001; Ramjeawon and Beedassy 2004; Badr 2009; Kolhoff et al. 2009; De Jong et al. 2012). It is worth evaluating the practices of impact assessment to address the biodiversity of development cooperation projects conducted by JICA and proposing a practical approach for mainstreaming biodiversity. Mainstreaming biodiversity into development cooperation projects can support conservation and the sustainable use of biodiversity in developing countries.

1. Experience so far

1.1 Mainstreaming biodiversity into development cooperation

The importance of mainstreaming biodiversity into development cooperation is enshrined in the Development Assistance Committee (DAC) Policy Statement of the Organisation for Economic Co-operation and Development (OECD) on Integrating Biodiversity and Associated Ecosystem Services into Development Co-operation (OECD 2010). The DAC Policy Statement emphasizes the importance of development co-operation agencies supporting partner countries to integrate biodiversity and ecosystem services into development policies, sector plans, and budget processes and to support the development of tools, practices, capacity, awareness, and governance frameworks necessary for mainstreaming processes to succeed. But environmental trends remain a low priority in development planning and policy formulation in the face of pressing needs for economic growth and given the scarcity of public and donor funding (Kosmus et al. 2012, p. 9).

Mainstreaming biodiversity and ecosystem services at the development planning level is limited due to a lack of awareness, recognition, or understanding of the importance of biodiversity and ecosystem services themselves, and a lack of low awareness of biodiversity-poverty linkages or of biodiversity-economy linkages (Dalal-Clayton and Bass 2009; Prip et al. 2010). This low level of awareness and understanding is exacerbated by: (1) the complexity and the multidimensional nature of these links; (2) a lack of economic valuation of biodiversity and ecosystem services; and (3) insufficient evidence in the form of case studies and success stories on the advantages of mainstreaming (IIED and UNEP-WCMC 2013, p. 35). As a countermeasure, the guide integrating ecosystem services into development planning was prepared, aiming to recognize the links between nature and development (Kosmus et al. 2012). Drutschinin et al. (2015) highlight good practices for minimizing tradeoff between biodiversity and development such as multi-stakeholder dialogue, a precautionary approach, and building governance, institutions, and legal frameworks.

1.2 Biodiversity-inclusive assessment

Biodiversity-inclusive assessment aims to identify and adaptively manage the impacts and risks of development in such a way that the variability of life on Earth is maintained in a healthy, functioning and connected state, and the benefits obtained from ecosystem goods and services extend into the future (IAIA 2013). Guiding principles on biodiversity-inclusive impact assessment aim for conservation and no net loss of biodiversity (IAIA 2005). Development cooperation agencies carry out EIA when cooperation projects are likely to have potentially adverse impacts on biodiversity. But biodiversity considerations are inadequately addressed in impact assessments and the quality of biodiversity information in EIA has been weak (Treweek 2001; Byron and Treweek 2005; Söderman 2005; Pritchard 2005; Slootweg et al. 2010). EIA reports often fail to identify which species are at risk if the development intervention is to materialize or fail to examine the reasons why they are threatened (Meynell 2005). The capacity of EIA to promote biodiversity conservation is largely unexplored (Mandelik et al. 2005a). Quantification and methods for biodiversity impact prediction in the EIA reports of road and railway projects from four EU countries are insufficient (Gontier et al. 2006). The predictions about biodiversity impacts were limited to only a small fraction of the ecological components such as trees, large animals, and endangered and rare species (Khera and Kumar 2010). To pave the way for explicitly addressing biodiversity issues in EIA, biodiversity impacts of development projects/interventions have to be identified, quantified, and valued (Wale and Yalew 2010).

The values of biodiversity may not be explicitly recognized by beneficiaries of ecosystem services, thus rendering them ‘invisible.’ While ecosystem services span global to local scales, stakeholder engagement and impact assessment often look solely at implications for local ecosystem services (Brownlie et al. 2013). The biodiversity and ecosystem services information in impact assessment is seldom captured adequately, creating an unreliable basis for the use of biodiversity offset approach and informing tradeoff decisions. Moreover, practical limitations in data availability and technical expertise in many countries exacerbate these shortcomings (Ugochukwu and Ertel 2008; Brownlie and Botha 2009; King et al. 2012). The main difficulties in incorporating biodiversity in EIA include: (a) absence or inadequate representation of the effect on ecosystem functions due to a lack of regional biodiversity data; (b) ill-defined baseline ecosystem conditions; (c) a lack of consideration of the cumulative effects of projects; (d) inadequate mitigation and post-monitoring; (e) a lack of quality control; and (f) poor stakeholder participation. (Thompson et al. 1997; Atkinson et al. 2000, 2006; Mandelik et al. 2005b; Söderman 2005, 2006; Wegner et al. 2005; Gontier et al. 2006; Geneletti 2006). Clearly, a precautionary approach is crucial (FFI 2005). The uncertainty and the limits to our current knowledge of biodiversity impacts, and precautionary approaches in decision making are recognized in global texts such as CBD (UN 1992a) and Rio Declaration (UN 1992b) aa well as impact assessment literature (Geneletti et al. 2003; Slootweg et al. 2010; Jalava et al. 2013). Relative to natural capital, assets embodied in ecosystems are poorly understood, scarcely monitored, typically undervalued, undergoing rapid, unchecked degradation, and recognized ‘only upon their loss’ (Ehrlich et al. 2012). Enhancement benefits from biodiversity aim to reduce stress on ecosystem services and enhance the productive potential of both terrestrial and aquatic ecosystems to improve resource security for local communities, without jeopardizing existing biodiversity (Rajvanshi et al. 2011).

1.3 Mitigation hierarchy

Biodiversity-inclusive assessment is increasingly striving to achieve a ‘no net loss,’ or preferably a ‘net positive impact’ outcome for biodiversity according to the mitigation hierarchy (IAIA 2013). The mitigation hierarchy is a tool to aid in the sustainable management of living, natural resources, which provides a mechanism for making explicit decisions that balance conservation needs with development priorities (Ekstrom et al. 2015, p. 8). Another definition of mitigation hierarchy is: ‘the sequence of actions to anticipate and avoid impacts on biodiversity and ecosystem services; and where *avoidance* is not possible, *minimize*, and, when impacts occur, *restore*, and where significant residual impacts remain, *offset*’ (CSBI 2013). The mitigation hierarchy includes a hierarchy of steps: avoidance, minimization, rehabilitation/restoration, and offset (Figure 1, BBOP 2012a). The application of the mitigation hierarchy is one of the key issues for consideration in biodiversity offset design.

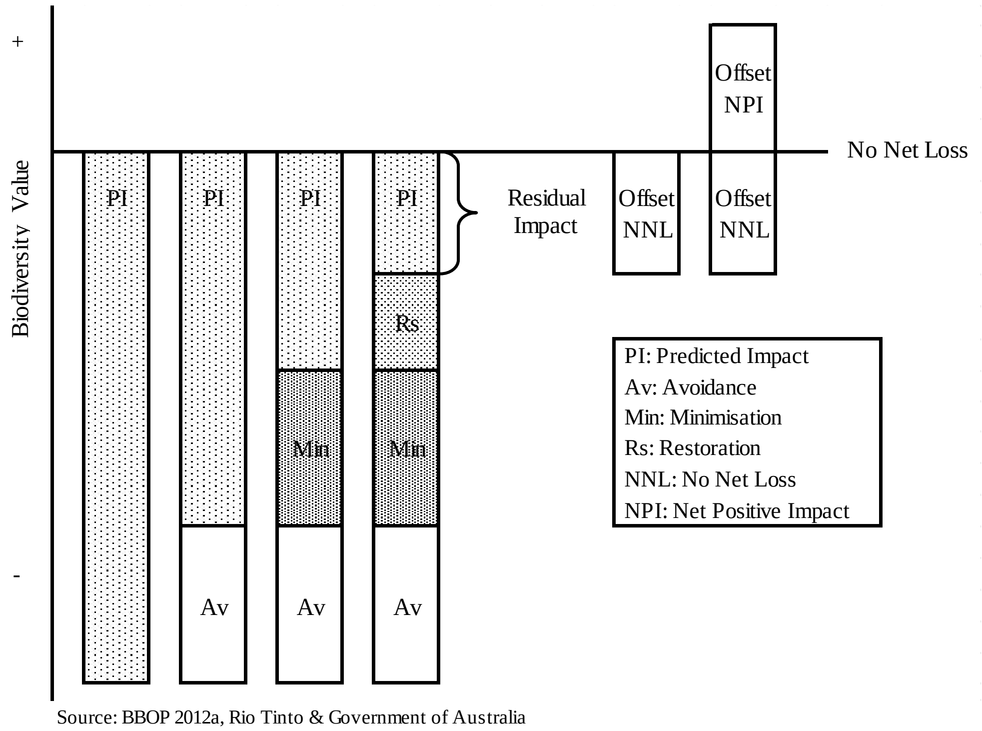

Figure 1. Mitigation hierarchy

The mitigation hierarchy is defined as a set of the following prioritized approaches or actions:

- Avoidance: measures taken to avoid creating impacts from the outset, such as careful spatial or temporal placement of elements of infrastructure, in order to completely avoid impacts on certain components of biodiversity.
- Minimization: measures taken to reduce the duration, intensity and/or extent of impacts (including direct, indirect, and cumulative impacts, as appropriate) that cannot be completely avoided, as far as is practically feasible.
- Rehabilitation/restoration: measures taken to rehabilitate degraded ecosystems or restore cleared ecosystems following exposure to impacts that cannot be completely avoided and/or minimized.
- Offset: measures taken to compensate for any residual significant, adverse impacts that cannot be avoided, minimized, and/or rehabilitated or restored, in order to

achieve no net loss or a net gain of biodiversity. Offset can take the form of positive management interventions such as the restoration of degraded habitat, arrested degradation or averted risk, or the protection of areas where there is imminent or projected loss of biodiversity.

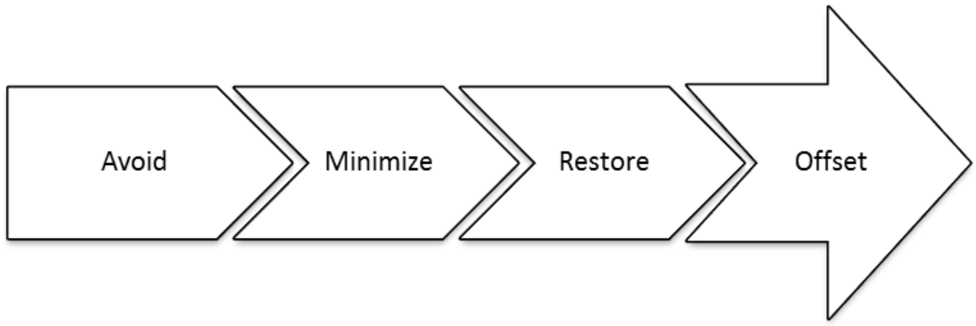

Figure 2. Avoid, minimize, restore, and offset
Source: Ekstrom et al. 2015, p.14

A project's predicted impact can be reduced by taking measures to avoid, minimize, and restore impacts, but a significant residual impact remains; this can be remediated via an offset. The mitigation hierarchy is a hierarchy in terms of priorities (Figure 2). The earlier components need special emphasis. Rigorous efforts to avoid and minimize as far as feasible are likely to achieve significant reductions in the predicted impact. Careful implementation of the early components of the mitigation hierarchy will reduce the project's liability for restoration and offset measures (Ekstrom et al. 2015, p. 14). These later mitigation components may often encounter the following: (1) increasing technical, social, and political risks (e.g. the technical failure of restoration, or the political failure of a biodiversity offset); (2) increasing uncertainty of costs, and a risk of cost escalation; (3) increasing costs per unit of biodiversity and ecosystem services; (4) increasing requirements for external stakeholder engagement and specialist expertise; (5) decreasing opportunity to correct mistakes; and (6) decreasing confidence and trust among key stakeholders. However, the opportunity costs of avoidance and minimization may often be larger for the project site than for other ecologically similar areas. There may thus be a strong economic rationale for restoration and (especially) offset to be favored over avoidance and minimization in addressing potential impacts. In practice, therefore, the tradeoff between environmental and economic effectiveness may need to be considered and resolved.

In actuality, the mitigation hierarchy is poorly applied (Darbi et al. 2009; Clare et al. 2011). In many instances, actions intended as offset in EIA result only in compensation, with the ongoing loss of biodiversity (Rajvanshi et al. 2010). In many instances, ecological compensation actions are only partially achieved (Brown et al. 2013); this seemingly intractable problem has been documented for many years (Treweek 1996; Slootweg et al. 2010). Although offset should only be adopted as a last resort to address residual impacts of development, it can be a powerful tool to use market mechanisms in order to achieve no net loss. Mitigation banks transacted an estimated $3.6 billion in 2016, with the largest markets in the United States, Australia, Germany, and Canada (Bennet et al. 2017). The energy, transportation, and mining/minerals sectors were responsible for more than 97% of offset and compensation measured by cumulative land area under management. Forest projects were the most common activities by cumulative land area in Latin America, Asia, Africa, and the Middle East (Bennet et al. 2017). Biodiversity offset in France suffers from a lack of formal methods for designing and sizing offset requirements (Quétier and Lavorel 2011), and the French guidance does not address the institutional arrangements and science base needed to reach the policy’s objective of no net loss (Quétier et al. 2013). The development of biodiversity offset faces conceptual and practical challenges. The conceptual challenges are: choice of metric, spatial delivery of offset, equivalence, additionality, timing, longevity, ratios, and reversibility. The practical challenges are: compliance, monitoring, transparency, and timing of credits release (Bull et al. 2014; Gonçalves et al. 2015).

The examples of offset in developing countries are: (a) offset in Western Cape Province, South Africa (BBOP 2009); (b) emerging offset framework in Uganda (Ministry of Water and Environment n.d.); (c) Ambatovy mine in Madagascar (BBOP 2014); (d) compensatory afforestation program in India (Ministry of Law and Justice 2016); and (e) new Forest Code and implementation of a rural environmental registry in Brazil (Soares-Filho et al. 2016). The International Finance Corporation (IFC) launched its Performance Standard 6, which requires borrowers to take steps to achieve no net loss in biodiversity. As of 2017, nine active IFC projects were carrying out offset activities in Cameroon, Colombia, Lao People's Democratic Republic, Madagascar, Mexico, Mongolia, Panama, Senegal, and Uganda. Mainstreaming biodiversity conservation into infrastructure planning and development through the mitigation hierarchy is one way to ensure that new growth is matched by new conservation efforts. But the mitigation hierarchy is often implemented improperly. Offset programs often operate with little transparency, billions of dollars in compensation funds remain unspent, and regulations designed to ensure no net loss are not always being enforced (Bennett et al. 2017). However, the use of offset in developing countries offers collateral benefits, which include promoting stakeholder engagement in conservation, leveraging funding to meet strategic conservation objectives, catalyzing improvements in environmental legislation, increasing baseline ecological knowledge, and expanding scientific capacity (Bull et al. 2013).

South Africa developed draft guidelines for biodiversity offset in the Western Cape in 2007. The main challenges in implementing the system of biodiversity offset are: (a) monitoring conversions of ecosystems on a regular basis; (b) managing the increased work of biodiversity conservation resulting from monetary compensation; (c) understanding interests of government departments and conservation agencies regarding offset funds; and (d) guaranteeing the safety and audit performance of offset funding (Brownlie and Botha 2009). After that, South Africa had a decade of experience designing and implementing biodiversity offset, and found the use of offset has frequently been inadequate to deliver intended biodiversity outcomes. Challenges are:

(a) the absence of national policy to drive and shape offset implementation; (b) insufficient capacity to evaluate, design, and implement offset; (c) inconsistent decision making; (d) problems establishing sustainable financing mechanisms; and (e) inadequate enforcement and monitoring, linked to poor drafting of licencing conditions and/or insufficient capacity to monitor implementation (Brownlie et al. 2017). Literature has emphasized theoretical and technical issues (Pilgrim and Ekstrom 2014) and theoretically robust offset methodologies (BBOP 2009; Gardner et al. 2013). Experience from South Africa, however, highlights broader contextual challenges influencing offset outcomes and the crucial role of systems that enable and support offset implementation. Lukey et al. (2017) concluded that making offset work in South Africa is more about communication, clarity of intent, transparency, capacity building, and creating policy that can be implemented without an enormous investment in governance infrastructure.

1.4 Green infrastructure

The world population is expected to grow from 7.6 billion in 2017 to 9.8 billion by 2050 (UNDESA 2017). Human population growth leads to the loss of biodiversity. The need to address many problems simultaneously is what makes green infrastructure cost-effective and efficient. Green infrastructure is a phrase referring to the conversion of a gray infrastructure (transportation, potable water, sewage treatment, communications, energy generation, etc.) to a more renewable or sustainable one. Connectivity between spaces large enough to support ecosystem functions and human use is a critical characteristic. Multiple functions are other key aspects of the definitions (Austin 2014, p. 3-4). The concept of green infrastructure can be considered to comprise all natural, semi-natural, and artificial networks of multifunctional ecological systems within, around, and between urban areas, at all spatial scales. Ecosystem services provided by green infrastructure can provide healthy environments and physical and psychological health benefits to the residents (Tzoulas et al. 2007). Green infrastructure can be broadly defined as a strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in rural and urban settings (EC 2013).

If a green infrastructure is proactively planned, developed, and maintained it has the potential to guide urban development by providing a framework for economic growth and nature conservation (van der Ryn and Cowan 1996; Schrijnen 2000; Walmsley 2006). Vegetation in Bangalore's slums in India appears to play a significant role in improving social capital, livelihoods, health, and nutrition (Gopal and Nagendra 2014). Within the urban ecosystem, the amount of vegetated area and patch isolation are two key landscape factors affecting biodiversity. A high amount of vegetated area increases species richness and the abundance of most arthropod groups (Turrini and Knop 2015). Biodiversity is intrinsically linked with green infrastructure in cities. Green infrastructure is the primary way that biodiversity is protected and enhanced in the built environment (Sinnett 2015). Urban vegetation has a positive impact on urban air pollution, climate change, and increasing urban temperatures (Demuzere et al. 2014; Tallis et al. 2015). The wise use of wetlands is one solution to the problems of water scarcity, urban wastewater, and fertilizer overuse all together in an arid land of China (Huang 2017). Green infrastructure is a cost-effective, resilient approach to managing wet weather impacts that provides many community benefits. Green infrastructure reduces and treats storm water at its source while delivering environmental, social, and economic benefits (EPA n.d.). Significant use of green infrastructure for a range of provisioning cultural services as well as its contribution to spiritual and mental wellbeing is recognized (Shackleton et al. 2017).

1.5 Ecosystem-based disaster risk reduction (Eco-DRR)

It is widely accepted that the environment, development, and disaster are linked. Disasters can have adverse consequences on the environment. On the other hand, environmental degradation itself is a major driver of disaster risk. Ecosystem services can be harnessed for hazard mitigation, disaster recovery, climate change mitigation and adaptation, livelihood development, and poverty reduction (Estrella and Saalismaa 2013). Ecosystems contribute to reducing the risk of disasters in multiple and varied ways. Well-managed ecosystems can reduce the impact of many natural hazards, such as landslides, flooding, avalanches, and storm surges. This natural infrastructure is often less expensive than human-built infrastructure (Sudmeier-Rieux et al. 2013). In combination with land use planning/zoning, higher seawalls, water channels, and deeper river beds (to hold more water), coastal forests can provide an effective option for multiple defenses to tsunamis (Renaud and Murti 2013). Economic valuation can play a very important role in ecosystem management decision-making (Uy and Shaw 2012). For example, the economic value of mangrove ecosystem services is estimated as an economic part of climate-compatible development infrastructure in coastal zones of Sri Lanka and Kenya (Emerton et al. 2016).

Ecosystem-based approaches mitigate drought impacts in Sub-Saharan Africa while providing multiple co-benefits which contribute to poverty alleviation and sustainable development, food security, biodiversity conservation, carbon sequestration, and livelihood resilience (Kloos and Renaud 2016). In Japan, after the massive damage from the Great East Japan earthquake and tsunami in 2011, ecosystem-based approaches were important elements of the government’s DRR efforts. The Eco-DRR is a socially, economically, and environmentally sustainable tool for DRR (Takeuchi et al. 2016). Coastal dunes provide protection against coastal hazards such as storms and tsunamis. However, in developing countries they are severely threatened by coastal development (Nehren et al. 2016). Fodder banks have been discussed as an ecosystem-based solution that can address forest degradation in the Indian Himalayan region (Dhyani and Dhyani 2016). Forests and trees are important in supporting rural community resilience to climate vulnerability in Indonesia (Fedele et al. 2016). A mechanism to evaluate the functions of Eco-DRR has been developed like Web-GIS based Ecological Infrastructure Environmental Information System (Doko et al. 2016).

The government of Japan (GOJ) prepared a handbook of Eco-DRR (MOE 2016) that explains four benefits, which are: (a) risk reduction before disaster and recovery support of lifelines during the post-disaster phase; (b) effectiveness against various types of disaster (storms, heavy rains, debris flows, floods, and tsunamis); (c) low construction and operation and maintenance costs; and (d) ecosystem services during non-disaster times (water, food, fuel, landscape, habitats for wild species, and recreational attractions). The Eco-DRR has been increasingly incorporated into the policies and planning of the GOJ, such as the National Biodiversity Strategy 2012－2020, the Basic Act for National Resilience in 2013, the National Land Use Planning in 2015, and the Fourth Priority Plan for Social Infrastructure Development in 2015. JICA also prepared a handbook of Eco-DRR (JICA et al. 2017) based on the review result of the past 20 forestry management projects around the world (including mangrove and coastal forests) and discusses the possibility of future Eco-DRR projects.

2. Data and methods

2.1 Selection of sample

This paper examines evaluation criteria for alternatives analysis and mitigation measures of 120 EIA reports prepared by JICA during 2001－2012, to review the level at which biodiversity issues are addressed in EIA, and to identify the measures proposed to mitigate the adverse impacts of biodiversity. A total of 120 samples representing 10 reports per year over 12 years were randomly selected using the random number table. The population was derived from a list of yearly reports pulled from the JICA library website. The random sample is meant to be an unbiased representation of the population, and it is reasonable to make generalizations from the results of the sample back to the population. The number of reports and the ratio by sectors and regions, and the period of four-year intervals is shown in Table 1 and Figure 3. The number of reports and ratio in transportation is 47 and 39%. Next to transportation, 21 and 18% are in regional development, 19 and 16% in power, 17 and 14% in water resource, 11 and 9% in pollution control, and 5 and 4% in agriculture. As for regions, Asia contributes the most reports, 70 and 58% in total. Next to Asia, 16 and 13% are from Africa, 15 and 13% from the Middle East, 12 and 10% from South America, 5 and 4% from Europe, and 2 and 2% from the Pacific.

Table 1. Distribution in sectors, regions, and periods of four-year intervals (n=120)

Period	Transportation		Regional development		Power		Water resource		Pollution control		Agriculture		Total
2001-2004	18	45%	5	13%	4	10%	6	15%	5	13%	2	5%	40
2005-2008	16	40%	7	18%	9	23%	4	10%	4	10%	0	0%	40
2009-2012	13	33%	9	23%	6	15%	7	18%	2	5%	3	8%	40
Total	47	39%	21	18%	19	16%	17	14%	11	9%	5	4%	120

Period	Asia		Africa		Middle East		South America		Europe		Pacific		Total
2001-2004	23	58%	3	8%	4	10%	8	20%	2	5%	0	0%	40
2005-2008	25	63%	3	8%	5	13%	4	10%	2	5%	1	3%	40
2009-2012	22	55%	10	25%	6	15%	0	0%	1	3%	1	3%	40
Total	70	58%	16	13%	15	13%	12	10%	5	4%	2	2%	120

Figure 3. Ratio by sectors and regions of 120 reports reviewed

2.2 Quantitative text analysis

The evaluation criteria for alternatives analysis (e.g. natural environment, social environment, regional economy, resettlement, cost, land use, investment) and topics of mitigation measures (e.g. water quality, flora and fauna, resettlement, employment, landscape) are selected from 120 EIA reports, changed to text data, and analyzed using quantitative text analysis (QTA) via KH

Coder, free analytical software (Higuchi 2014). The QTA is a method of content analysis for analyzing text data using quantitative analysis methods. This is in contrast to the qualitative analysis method that is often employed, in which analysts quote typical passages from the original data and then interpret them. In this method, it is difficult to determine how quoted passages catch the attention of analysts or whether they are in fact typical. The QTA, on the other hand, provides a quantitative overview of text data that accounts for quoted passages. One benefit of QTA is that it allows analysts to use coding rules (rules to classify text data into the specified categories) to search data that is overlooked or hardly noticed in a normal reading of the documents, and then to count their frequency. Another benefit is the ability to compare text data with others by comparing the appearance ratio, which is calculated by dividing the number of paragraphs in which specific coding rule words appear by the total number of paragraphs.

The coding rules of this paper were prepared to focus on four issues (environmental issues, biodiversity issues, social issues, and economic issues) to compare the appearance ratio of biodiversity with other issues. Related words on four issues with the frequency (two or higher) are searched from text data and those words are used for coding rules (e.g. biodiversity issues by fauna, flora, ecosystem, biodiversity, or vegetation). The words that appeared only one time are excluded from the coding rules because there are a very large number and it is thought that the influence is small. Evaluation criteria and mitigation measures are analyzed by using the coding rules, and the number of reports, the appearance ratio, and the chi-square are calculated. Articles, pronouns, figures, punctuation marks, and so on were excluded from the analysis as they were unnecessary. The number of reports corresponding to each coding rule is counted according to each period and sector. The chi-square test is used to test the difference in frequency between periods and sectors. The difference with $*p < .05$ is considered significant. The QTA was applied to some EIA studies, such as a literature review of EIA system in developing countries (Kamijo and Huang 2017a) and the analysis of the minutes of meetings contained in EIA reports (Kamijo and Huang 2017b).

2.3 Classification of mitigation measures

Proposed biodiversity mitigation measures are classified into three types of mitigations—avoidance, minimization, and compensation—according to three groups of treatment—both processes of alternatives analysis and mitigations, only alternatives analysis, and only mitigations. Both processes of alternatives and mitigations mean that biodiversity issues are included for alternatives analysis and biodiversity mitigation measures are proposed; alternatives only means that biodiversity issues are included for alternatives analysis but biodiversity mitigation measures are not proposed; and mitigations only mean that biodiversity mitigation measures are proposed but biodiversity issues are not included for alternatives analysis. At the end, the specific mitigation measures are listed with their frequency according to avoidance, minimization, and compensation by reading each report.

3. Results

3.1 Related words of environmental, biodiversity, social, and economic issues and their frequency

The related words of environmental, biodiversity, social, and economic issues and their frequency are extracted from the text data (Table 2). The number of reports having evaluation criteria for alternatives analysis and mitigation measures is 64 and 101 respectively. Related words with a high frequency of environmental issues (including biodiversity) in the evaluation criteria and mitigation measures are: environment (24), water (16), noise (7), and air (6); and pollution (84), water (83), noise (59), and air (53). In biodiversity, they are: biodiversity (6), natural (4), protected (4), and ecology (2); and fauna (19), flora (19), ecosystem (13), and biodiversity (8). In social issues, they are land (13), social (12), resettlement (10), and acquisition (9); and resettlement (54), accident (26), heritage (23), and health (12). In economic issues, they are cost (31), economy (25), construction (9), and traffic (7); and economy (22), land use (18), traffic (16), and fishery (7). These words represent the interests of project proponents and participating stakeholders. The words in Table 2 are used for coding rules on environmental, biodiversity, social, and economic issues to count the number of relevant reports. Fifty-six reports do not describe alternatives and that 19 do not describe mitigation measures. The words and the frequency of evaluation criteria and mitigation measures in biodiversity are small and low compared to environmental and social issues (Figure 4). In particular, considerations of biodiversity issues for alternatives analysis are very limited (6%).

Table 2. Related words of four issues and their frequency by criteria and mitigations

Issues	Evaluation criteria	Mitigation measures
Environmental issues	environment (24), water (16), noise (7), air (6), biodiversity (6), pollution (6), vibration (6), geology (5), GHG (greenhouse gas) (5), environmental (4), natural (4), protected (4), stability (4), topography (4), waste (4), hydrology (3), landscape (3), soil (3), ecology (2), ecosystem (2), emission (2), erosion (2), groundwater (2), marine (2), physical (2), sediment (2)	pollution (84), water (83), noise (59), air (53), waste (44), vibration (39), soil (27), landscape (23), fauna (19), flora (19), odor (19), hydrology (15), ecosystem (13), groundwater (13), erosion (12), biodiversity (8), vegetation (7), sediment (6), topography (6), wildlife(5), climate (4), dust (4), ecology (4), flood (4), geology (4), GHG (4), subsidence (4), deforestation (3), drainage (3), forest (3), sludge (3), tree (3), coast (2), fish (2), mangrove (2), park (2), protected (2)
Biodiversity issues	biodiversity (6), natural (4), protected (4), ecology (2), ecosystem (2), marine (2)	fauna (19), flora (19), ecosystem (13), biodiversity (8), vegetation (7), wildlife (5), ecology (4), deforestation (3), forest (3), tree (3), fish (2), mangrove (2), park (2), protected (2)
Social issues	land (13), social (12), resettlement (10), acquisition (9), heritage (4), infrastructure (4), society (4), socio (4), facility (3), safety (3), accident (2), culture (2), minority (2), population (2), poverty (2)	resettlement (54), accident (26), heritage (23), health (12), infrastructure (12), conflict (11), safety (11), employment (10), land (10), disease (8), sanitation (8), acquisition (7), community (7), HIV/AIDS (7), vulnerable (7), inequality (6), utility (4), social (4), culture (2), facility (2), gender (2), institution (2), livelihood (2), poor (2)
Economic issues	cost (31), economy (25), construction (9), traffic (7), development (6), access (5), landuse (5), investment (4), power (4), technology (4), benefit (3), IRR (internal rate of return) (3), tourism (3), congestion (2), demand (2), employment (2), network (2), operation (2), relevance (2), speed (2), transport (2), urban (2)	economy (22), landuse (18), traffic (16), fishery (7), access (4), transportation (4), transport (2)
No mention	no alternatives (56)	no mitigation measures (19)

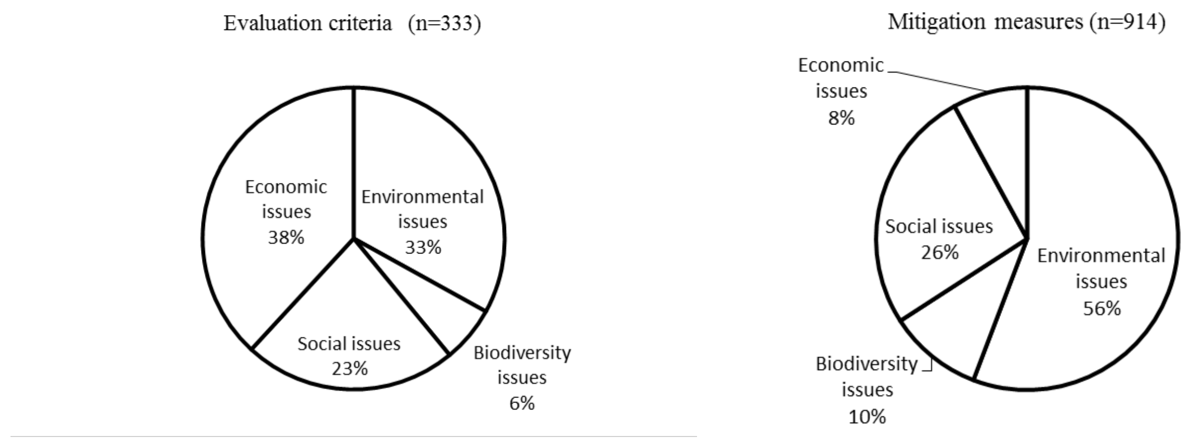

Figure 4. Ratio of frequency of related word on four issues

3.2 QTA result of evaluation criteria for alternatives analysis

The QTA result of evaluation criteria by periods and sectors is shown in Table 3. The number of reports and the appearance ratio about biodiversity issues is 15 of 120 and 13% in total, which is very small and low compared to environmental, social, and economic issues. The number and ratio of biodiversity increase gradually with the lapse of time like the other three issues. The reason may be mandating alternatives analysis for large-scale projects by the introduction of JICA EIA guidelines in 2004. The chi-square of biodiversity by period and sectors does not show significant difference. The power sector analyzes relatively more the biodiversity issues (21%) while the sectors of regional development, pollution control, and agriculture hardly analyze them (5%, 0%, and 0%).

Table 3. QTA result of evaluation criteria (Significant at *p < .05)

Period and sector	Environmental issues		Biodiversity issues		Social issues		Economic issues		No alternative		Total
2001-2004	13	33%	2	5%	8	20%	13	33%	24	60%	40
2005-2008	17	43%	6	15%	15	38%	19	48%	16	40%	40
2009-2012	21	53%	7	18%	16	40%	21	53%	16	40%	40
Total	51	43%	15	13%	39	33%	53	44%	56	47%	120
Chi-square		3.3		4.0		4.3		3.5		4.3	
Transportation	23	49%	8	17%	19	40%	25	53%	17	36%	47
Regional development	7	33%	1	5%	6	29%	8	38%	12	57%	21
Power	9	47%	4	21%	6	32%	10	53%	8	42%	19
Water resource	5	29%	2	12%	5	29%	6	35%	11	65%	17
Pollution control	5	45%	0	0%	3	27%	4	36%	5	45%	11
Agriculture	2	40%	0	0%	0	0%	0	0%	3	60%	5
Total	51	43%	15	13%	39	33%	53	44%	56	47%	120
Chi-square		2.9		7.2		4.1		7.2		5.8	

Note: The sum of all five totals does not match with the total number of reports. Some reports have two issues or more.

3.3 QTA result of mitigation measures

The QTA result of mitigation measures by periods and sectors is shown in Table 4. The number of reports and the appearance ratio about biodiversity is 55 of 120 and 46% in total, which is small and low compared to the environmental and social issues (96 and 80%; 84 and 70%). The chi-square of biodiversity by periods is only 0.9. The appearance ratio of biodiversity is not different by periods even by the introduction of JICA guidelines in 2004. On the other hand, the chi-square of biodiversity by sectors is 8.9. The difference is not significant but the variation by sectors is large compared to other three issues. The power sector has comparatively a large number of biodiversity mitigation (63%). On the other hand, the regional development sector pays less attention to it (24%).

Table 4. QTA result of mitigation measures (Significant at *$p < .05$)

Period and sector	Environmental issues		Biodiversity issues		Social issues		Economic issues		No mitigation		Total
2001-2004	34	85%	20	50%	31	78%	18	45%	4	10%	40
2005-2008	32	80%	19	48%	29	73%	25	63%	7	18%	40
2009-2012	30	75%	16	40%	24	60%	18	45%	8	20%	40
Total	96	80%	55	46%	84	70%	61	51%	19	16%	120
Chi-square		1.3		0.9		3.1		3.3		1.6	
Transportation	39	83%	22	47%	34	72%	24	51%	7	15%	47
Regional development	17	81%	5	24%	15	71%	13	62%	2	10%	21
Power	14	74%	12	63%	12	63%	10	53%	3	16%	19
Water resource	13	76%	7	41%	11	65%	6	35%	4	24%	17
Pollution control	9	82%	5	45%	9	82%	5	45%	2	18%	11
Agriculture	4	80%	4	80%	3	60%	3	60%	1	20%	5
Total	96	80%	55	46%	84	70%	61	51%	19	16%	120
Chi-square		0.9		8.9		1.8		3.0		1.5	

Note: The sum of all five totals does not match with the total number of reports. Some reports have two issues or more.

3.4 Avoidance, minimization, and compensation of biodiversity impacts

The number of reports that describe biodiversity issues in both alternatives analysis and mitigations, only alternatives, and only mitigations is 8, 7, and 47 respectively (Table 5). The number of reports that propose avoidance, minimization, and compensation, is 6, 36, and 32 respectively. The specific mitigation measures and their frequency are shown by avoidance, minimization, and compensation in Table 6. The avoidance is very scarce and only 6 of 62 reports explain the avoidance measures. In most cases minimization or compensation measures are proposed without considering avoidance and thereby violating the principle of mitigation hierarchy. Only 2 of 15 reports (both processes and only alternatives) propose the avoidance through consideration of alternatives analysis (Table 5). The common compensation measures are reforestation and migration of endangered species.

Table 5. Biodiversity mitigation hierarchy

Group	Avoidance		Minimization		Compensation		Total
Both processes	1	13%	5	63%	3	38%	8
Only alternatives	1	14%	5	71%	1	14%	7
Only mitigations	4	9%	26	55%	28	60%	47
Total	6	10%	36	58%	32	52%	62
Chi-square	0.32		0.72		5.11		

Note: The sum of all three totals does not match with the total number of reports. Some reports have two measures or more.

Table 6. Biodiversity mitigation measures and their frequency

Avoidance
Selection of an alternative having no impact (2)
Habitat (1)
Natural forest (1)
Protected area (1)
Water resource (1)
Minimization
Habitat including protected area, endangered species, and wetlands (15)
Forests (14)
Maintaining water flow (3)
Selection of an alternative having less impact (2)
Road kill (2)
Poaching (2)
Bird strike (1)
Landfill covered with soil (1)
Compensation
Reforestation (16)
Migration of animals and plants (11)
Solving segmentation using corridor and fishladder (7)
Revegetation (4)
Habitat regeneration (3)

4. Discussion

4.1 Insufficient biodiversity-inclusive assessment in JICA development projects

Only 15 of 120 projects analyze the biodiversity issues in the consideration of alternatives and only 2 of 15 projects propose avoidance measures (Table 5). The consideration of alternatives is not utilized effectively to select a suitable alternative to avoid and minimize predicted adverse impacts on biodiversity. The most of proposed mitigation measures is the minimization or compensation without alternatives analysis, and the mitigation measures are stated very short and not individually or specifically. The reason is because project proponents and JICA still may put a high priority on economic growth than the biodiversity conservation and does not introduce the offset and mitigation hierarchy yet. According to the mitigation hierarchy every project has to take avoidance measures first but they are not taken in account in most cases. The present JICA biodiversity-inclusive assessment does not achieve the goal of no net loss. No report quantifies predicted adverse impacts and parts of avoidance, minimization, and compensation. Biodiversity loss may continue due to development in developing countries if biodiversity-inclusive assessment continues the way it is now.

JICA guidelines explain that plural alternatives must be examined in order to avoid or minimize adverse impacts and to choose better environmental and social options. The priority of mitigation measures is to be given to avoidance of environmental impacts; when this is not possible, minimization of impacts must be considered next. Compensation measures must be examined only when impacts cannot be avoided by any of the aforementioned measures (JICA 2010, p. 28). This guidance appears to follow the mitigation hierarchy. But in many cases, biodiversity mitigation measures are prepared to a narrow range and to an insufficient degree qualitatively. Because the present guidelines rely on the ownership of project proponents in recipient countries and do not indicate the goals to be achieved like no net loss according to mitigation hierarchy. One solution is to improve the alternatives analysis in order to avoid and minimize adverse impacts on biodiversity. The introduction of mitigation hierarchy may powerfully motivate project proponents to increase a portion of avoidance and minimization, and to reduce a portion of restoration and offset. The reason is because restoration and offset measures may increase technical and social risks, and uncertainty of cost and time escalation. The avoidance and minimization are examined by selecting a good environmental and social option through alternatives analysis. The present number of biodiversity issues for evaluation criteria for alternatives analysis is too few at the moment (only 13%, Table 3). Every development cooperation project should analyze alternatives also from biodiversity point of view by adding biodiversity issues to evaluation criteria.

4.2 Application of mitigation hierarchy to all development projects

Application of the mitigation hierarchy is fundamental to environmental best-practice (IAIA 2005; McKenney and Kiesecker 2010; BBOP 2012b). In many cases, even low-quality, incomplete, impermanent, and poorly implemented biodiversity offset approaches according to the mitigation hierarchy could provide more positive outcomes for biodiversity than a status quo of limited or inadequate compensation. Avoidance and minimization, the first steps in the mitigation hierarchy, will usually be optimal for biodiversity (Pilgrim and Ekstrom 2014). Most of JICA projects develop forests, wetlands, and other habitats, and mitigate the adverse impact through reforestation and the migration of endangered species as compensation. JICA should ensure that the avoidance and minimization measures are taken through the application of the mitigation hierarchy in all development projects. A suitable alternative to avoid and minimize impacts should be selected through the discussion of alternatives with stakeholders. It is preferable to reduce residual impacts while avoiding and minimizing adverse impacts as much as possible.

4.3 Wise use of ecosystem services using green infrastructure and Eco-DRR

Even after the adoption of measures to avoid, minimize, and restore impacts through the application of the mitigation hierarchy, the residual impacts still remain, and it would be difficult for JICA to implement offset in practice due to lack of experience at the moment. The literature on green infrastructure and Eco-DRR shows the multipurpose effects of ecosystem services. JICA should incorporate ecosystem services into project plans; as a consequence, the predicted impact would be reduced and the majority of biodiversity would be conserved. At the same time local people and stakeholders can benefit from various ecosystem services, making it easier to build consensus on a proposed project. For example, despite the fact that mangrove forests provide multiple services including coastal defense, habitats and landscape, livelihoods, and carbon sequestration (Lacambra et al. 2013), some present projects allow the cutting of mangrove trees to construct concrete revetment structures. In particular, regional development has the capacity to incorporate green infrastructure and Eco-DRR into project components. The regional development that incorporates green infrastructure may be more advantageous compared to gray infrastructure not only from the standpoint of biodiversity conservation but also in terms of cost effectiveness, landscape quality, pollution control, welfare, disaster risk reduction, and consensus building.

Ecosystem-based solutions might provide more cost-effective options for development projects at a time when financial issues are even more of a priority for developing countries. The multipurpose effects of ecosystem services can be supported by a broad range of beneficiaries. Successful implementation of sustainable ecosystem management can be achieved only through changes in urban governance and decision-making processes, by adopting more integrated approaches through cross-sectoral and multi-stakeholder dialogue (Guadagno et al. 2013). The GOJ incorporated Eco-DRR into its policies after the Great East Japan Earthquake in 2011 and JICA also prepared the Eco-DRR handbook based on the experience of forest management projects. In this context it may be comparatively easy for JICA to start the Eco-DRR projects to incorporate ecosystem services at the moment. The wise use of ecosystem is one solution to improve mainstreaming biodiversity into development cooperation projects. JICA should begin to examine making wise use of green infrastructure and Eco-DRR to development cooperation projects.

4.4 Efforts to practice offsets

Offset is necessary to achieve no net loss; some developing countries (Brazil, India, Madagascar, South Africa, and Uganda) have already implemented offset, and the IFC has projects in Cameroon, Colombia, Lao People's Democratic Republic, Madagascar, Mexico, Mongolia, Panama, Senegal, and Uganda. JICA has not introduced the offset yet, but should start the preparation for the introduction of offset in order to completely mitigate adverse impacts of biodiversity due to development cooperation projects. In addition, the no net loss policy may be introduced to international cooperation in the near future. JICA has development cooperation projects in the above-mentioned countries and experience in forestry management projects (the main offset activity in developing countries). The offset can promote the improvement of biodiversity-inclusive assessments such as the baseline setting, quantified predictions, monitoring, management systems, restoration of degraded habitat, etc. It is preferable that JICA collects related information and prepares the offset plan.

4.5 Advantages and limitations of the QTA to review EIA reports

The QTA searches text data and counts the frequency using coding rules, then provides the overview of evaluation criteria and mitigation measures. In comparison to the qualitative analysis method, the advantage of QTA is that it becomes possible to analyze a lot of text samples while avoiding arbitrary operations and to provide an overview of samples. An analyst can understand the present situation of samples easily and explore important issues in depth. One of the limitations of QTA is that there is the risk that coding rules reflect the bias of an analyst. In order to address this limitation, it is appropriate to summarize and present the overall data and to open the coding rules to the public.

Conclusion

Biodiversity loss due to development continues in particular in developing countries though biodiversity-inclusive assessments have been implemented for a long time. The present biodiversity-inclusive assessment is insufficient, primarily because the inadequate analysis of alternatives does not avoid or minimize the adverse impacts. One solution is to mandate the application of mitigation hierarchy so that the alternatives analysis can be activated. The tradeoff between the environment and the economy is a difficult question for decision-makers and in most cases they prioritize economic growth, leading to the deteriorate of the environment including biodiversity. Green infrastructure can minimize the tradeoff relation, because it incorporates ecosystem services into project components. The wise use of ecosystem services is a potential solution to stop biodiversity loss and satisfy development needs. The introduction of the mitigation hierarchy and green infrastructure will be one practical approach to mainstreaming biodiversity. This approach can improve JICA development cooperation projects for conservation and the sustainable use of biodiversity. At the same time this approach can reduce the loss of biodiversity in developing countries. The progress toward the achievement of the Aichi Diversity Targets, which are targeted for completion in 2020, is lagging. JICA should fully mainstream biodiversity into development policy and practice through the application of the mitigation hierarchy, green infrastructure, and Eco-DRR without delay. At the same time, the JICA needs to develop its capacity to promote mainstreaming biodiversity in development cooperation projects in an effective way. Further research is needed to explore biodiversity-inclusive assessment and the wise use of ecosystem services in more depth.

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Abstract (in Japanese)

要約

生物多様性の重要性は認識されており、環境アセスメントは開発に伴う負の影響を最小化するための有益なツールとみなされている。しかし、生物多様性に対するアセスメントが長年行われてきたにもかかわらず、開発行為に伴う生物多様性の喪失は途上国において進行している。本ワーキングペーパーの目的は、開発協力事業における生物多様性保全の主流化を改善する実務的な手法を提案することである。国際協力機構が 2001 年から 2012 年にかけて作成した 120 冊の環境アセスメント報告書における生物多様性の緩和策を調査した。その結果、生物多様性への配慮は不十分であり、回避策が本当に少ないことが判明した。一方、生態系は多様な便益を有しており、生態系サービスの便益を開発事業に組み込むことが得策である。生物多様性のノーネットロスを目指したミティゲーション・ヒエラルキーと生態系サービスをうまく利用したグリーンインフラストラクチャーの適用は、生態系の喪失を止めるとともに開発ニーズを充足させる解決策となりうる。

キーワード：生物多様性、生態系サービス、ミティゲーション・ヒエラルキー、
グリーンインフラストラクチャー、生態系を活用した防災・減災

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