Schemes of the Nagoya Protocol as the Commons: Framework on Classifying Expected Benefits and Costs for Appropriate Utilization of Genetic Resources

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Abstract

This paper[2] highlights the relationship between sustainable utilisation of genetic resources under the Nagoya Protocol's schemes and principles of the long-ensuring commons through clarification of expected benefits and costs available by introduction of the Protocol.

The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity was adopted in 2010 in Nagoya, Japan, at the tenth meeting of the Conference of the Parties to the Convention on Biological Diversity (CBD COP10). The Convention (CBD) has three objectives: the conservation of biodiversity, the sustainable use of its components, and the faire and equitable sharing of the benefits arising out of utilisation of genetic resources (ABS). The Nagoya Protocol (NP) is a supplemental agreement to CBD. NP provides a legal framework for ABS that covers all the genetic resources and traditional knowledge(TK).

NP is related with the commons, especially from the viewpoints of institutions for sustainable utilisation of the resources and appropriate distributions of benefits and costs for stakeholders. Furthermore, TK covered by TK itself is very similar with the commons, because TK is basically regarded to be genetic resources and knowledge on sustainable utilisation of the resources that are communally owned by local community and/or indigenous people.

NP is expected to bring better management of biodiversity. When some stakeholders try to utilise resources under the schemes of NP, increases in benefits are expected, because resources are utilized by more sustainable ways by, for instance, bio-prospecting researches. In contrast, it has to bear some challenges. The stakeholders have to bear increases in costs that are needed when they set new procedures by requirements of NP. Some framework(s) must be useful to compare these costs and benefits especially when new NP is introduced, considering the relationship between NP and the commons.

Key Words: CBD, the Nagoya Protocol, Utilisation of Genetic Resources, Cost-Benefit Analysis (CBA), Principles of the Long-ensuring Commons

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Introduction – Objective, Background, Significance of the Paper

Objective

This paper highlights the relationship between sustainable utilisation of genetic resources under the Nagoya Protocol's schemes and principles of the long-ensuring commons through clarification of expected benefits and costs available by introduction of the Protocol.

Background

The Convention Biological Diversity (CBD) was adopted in 1992 at the United Nations Conference on Environment and Development (UNCED) - so to speak, the Rio Summit – and entered into force in 1993. CBD has three objectives: the conservation of biodiversity, the sustainable use of its components, and the faire and equitable sharing of the benefits arising out of utilisation of genetic resources (ABS).

The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity was adopted in 2010 in Nagoya, Japan, at the tenth meeting of the Conference of the Parties to CBD (CBD COP10). The Nagoya Protocol (NP) provides a legal framework for the third objective of CBD (*i.e.* ABS), functioning as a supplemental agreement to CBD. CBD has already stipulated ABS rules in Article 15 and in a few other articles. NP has been adopted, however, so that a new protocol can create greater legal certainty and transparency for both providers and users of genetic resources[3].

Significance

A research in this paper has significance below, bearing the background described above.

NP covers all the genetic resources and traditional knowledge (TK). Especially, the latter very often includes endemic and native species and consists of resources, institutions and users. The users can be called as appropriators in the context of comparison between NP and the commons. The appropriators are of indigenous people and local communities. Similarities between NP and the commons can hardly be denied if these elements are considered. An importance of highlighting the relationship can hardly be denied especially when NP is introducing and affecting TK in the real world.

[3] Nagoya Protocol Fact Sheet.

In the context of similarities, NP provides some platforms for institutional arrangement in both provider and user countries. Especially, NP tries to exclude, so to speak, appropriators as free riders, requiring legal arrangements to sovereign states. These legal arrangements affect indigenous and local communities and/or communities that bear the commons. Hence, researching NP is significant in the context of the commons researches.

NP is expected to bring better management of biodiversity. When some stakeholders try to utilise resources under the schemes of NP, increases in benefits are expected, because resources are utilized by more sustainable ways by, for instance, bio-prospecting researches. In contrast, it has to bear some challenges. The stakeholders have to bear increases in costs that are needed when they set new procedures by requirements of NP.

The long-ensuring commons has, in general, obtains appropriate rules/schemes of sharing of benefits that can be obtained through utilization of the resources and costs that are necessary to continue to be the commons members. A ratio between the benefits and costs must be one of the incentives for the members.

Hence, analysing these benefits and costs, clarifying both explicit and implicit benefits must be a prominent significance of the research in this paper.

1 Adoption and Characteristics of the Nagoya Protocol on ABS

Historical background and characteristics of NP is explained, before the relationships are described.

1.1 Adoption of the Protocol

The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity (NP) was adopted in 2010 at CBD COP10 as stated in the background above.

The World Summit on Sustainable Development (WSSD) held in 2002 stated on "international regime" on ABS in paragraph 44 (o) of *the Plan of Implementation*.

> (Parties should) negotiate within the framework of the Convention on Biological Diversity, bearing in mind the Bonn Guidelines, an international regime to promote and safeguard the fair and equitable sharing of benefits arising out of the utilization of genetic resources. (Plan of Implementation, the World Summit on Sustainable Development, http://www.johannesburgsummit.org/html/documents/summit_docs/2309_planfinal.htm)

In addition to this stipulation, the seventh Conference of the Parties to the Convention on Biological Diversity (CBD COP7) mandated, in its Decision Ⅶ/19D, Working Group on ABS with collaboration of the Working Group on 8(j) to negotiate an international regime on access and benefit-sharing with the aim of adopting an instrument/instruments to implement the provisions in Articles 15 and 8(j) and the three objectives of the Convention.

By these mandate and decision and though negotiations at several working groups, the international regime turned out to be the Nagoya protocol at CBD COP10 in 2010. The regime might have been other formats such as voluntary measures, a certificate, some standards (*e.g.* ISO series) and so forth. The regime, however, eventually, became the strictest format, say a protocol.

1.2 Characteristics of the Protocol

NP is a supplemental agreement to CBD. Its objective is the fair and equitable sharing of the benefits arising from the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding, thereby contributing to the conservation of biological diversity and the sustainable use of its components.

In this context, what should be noted is that NP covers are benefit-sharing arising out of all the genetic resources and traditional knowledge (TK) associated with genetic resources, while CBD covers that from solely genetic resources.

In order to pursuit this objective, NP is expected to create greater legal certainty and transparency for both providers and users of genetic resources through: 1) establishing more predictable conditions for access to genetic resources; and 2) helping to ensure benefit-sharing when genetic resources leave the contracting Party providing the genetic resources.

Obligations introduced by NP can be basically classified into three: 1) obligations on access; 2) obligation(s) on benefit-sharing; and 3) obligations on compliance. The obligations are summarised in Table 1.2-A.

Table 1.2-A Obligations Introduced by the Nagoya Protocol

Obligations on Access are to:	
	Create legal certainty, clarity and transparency
	Provide fair and non-arbitrary rules and procedures
	Establish clear rules and procedures for prior informed consent and mutually agreed terms
	Provide for issuance of a permit or equivalent when access is granted
	Create conditions to promote and encourage research contributing to biodiversity conservation and sustainable use
	Pay due regard to cases of present or imminent emergencies that threaten human, animal or plant health
	Consider the importance of genetic resources for food and agriculture for food security
Obligation(s) on benefit-sharing is to:	
	Provide for the fair and equitable sharing of benefits arising from the utilization of genetic resources, as well as subsequent applications and commercialization, with the contracting Party providing genetic resources. * In this situation, Utilization includes research and development on the genetic or biochemical composition of genetic resources. Sharing is subject to mutually agreed terms. Benefits may be monetary or non-monetary.
Obligations on compliance are to:	
	Take measures providing that genetic resources utilise within their jurisdiction have been accessed in accordance with prior informed consent, and that mutually agreed terms have been established, as required by another contracting Party
	Cooperate in cases of alleged violation of another contracting Party's requirements
	Encourage contractual provisions on dispute resolution in mutually agreed terms
	Ensure an opportunity is available to seek recourse under their legal systems when disputes arise from mutually agreed terms
	Take measures regarding access to justice

Source : (The) Secretariat of the Convention on Biological Diversity, Nagoya Protocol Fact Sheet

Table 2-A) Design Principles of Long-ensuring Commons

		Whether similar with NP
1	Cleary Defined Boundaries	
2	Congruence between appropriation and provision rules and local conditions Appropriation rules restricting time, place, and technology and/or quantity of resource units are related to local conditions and to provision rules requiring labour, material, and/or money.	✓
3	Collective Choice Arrangement Most individuals affected by operational rules can participate in modifying the operational rules.	✓
4	Monitoring Monitors are accountable to the appropriators or the appropriators.	✓
5	Graduated Sanctions	✓
6	Conflict resolution mechanisms	✓
7	Minimal recognition to Rights to Organise The rights of appropriators to device their own institutions are not challenged by external governmental organisations.	✓
8	Nested Enterprises	✓

Ostrom, E. (1990) p. 90 arranged by the author.

2 The Relationship between the Nagoya Protocol and the Commons

The relationships between NP and the commons are, here, explained. There are some similarities between NP and the long-ensuring commons principles. Table 2-A) specifies similarities between NP and the commons. As can be seen easily, except one principle, NP and the commons principles are very similar. Some prominent similarities should be explained below.

Firstly, regarding the first principle, "clearly defined boundaries", this is not similar, despite the fact that traditional knowledge (TK) and local communities related with genetic resources are expected to function as long-ensuring commons. TK paradoxically can hardly obtain clear defined boundaries, while the commons can. The reason for this is that TK itself is owned by a number of community people and it is difficult make a distinction between TK holder and non-TK holders, even if TK is contributing sustainable use of genetic resources. TK does exists but the "boundaries" are vague.

The second principle, "congruence between appropriation and provision rules and local conditions", is crucial when the relationship is considered. Especially, labour, material and money specified in the principles are important elements, because NP aims to optimise the benefit-sharing. Formats, quantity, and fairness are crucial criteria for NP. Criteria are expected to be satisfied amongst appropriators – from the viewpoint of TK, TK holders - and between the appropriators and external users.

Furthermore, "money" has two sides when the relationship is considered. In addition to benefits that are available from cooperation in the commons and from utilization of the resources, costs must be shared equally among resources users and this sharing should be congruent with local conditions AND the amount of benefits.

On the one hand, in addition to moral or ethical matters, one of the crucial principle that have been making the commons long-enduring must be an economic incentive –say, benefits. Strictly speaking benefits must be compared to costs always, because in order to obtain benefits, the appropriators have to supply labour that is regarded to be a cost. On the other hand, newly introduced NP is intended to maximise benefits. In this introduction, costs have to be borne by stakeholders. Moreover, some costs are important but implicit unless specified by some special knowledge. These implicit costs are overlooked or underestimated unless carefully specified. For instance, transaction costs and/or opportunity costs that are borne to establish/maintain benefit-sharing rules cannot be specified for beneficiaries unless these are highlighted by some economic analysis. Strict comparison between benefits and explicit and implicit costs for NP implementation, referring the long-ensuring principle of the commons is significant.

3 Framework on Classifying Expected Benefits and Costs[4]

A matter of comparison of benefits and costs is crucial as long as NP has similarities with the long-ensuring commons. Clarifying benefits and costs and setting a framework for this comparison must be useful for further exploring of the commons. In this section, values, benefits, and costs are clarified and a tentative framework to compare benefits and costs will be introduced.

3.1 Clarifying the Option Value in the Context of all the Economic Values available from Biodiversity including Genetic and Biological Resources

3.1.1 Multiple Values of Biodiversity

In the last few decades, many economic values of the environment including biodiversity have been recognised. Here, the notion of economic values is re-classified and re-clarified in the context of ABS. The latest classification of economic values is shown in Chart 3.1-A. This classification has been proposed by Pearce *et al* (2006), previous classifications being improved.

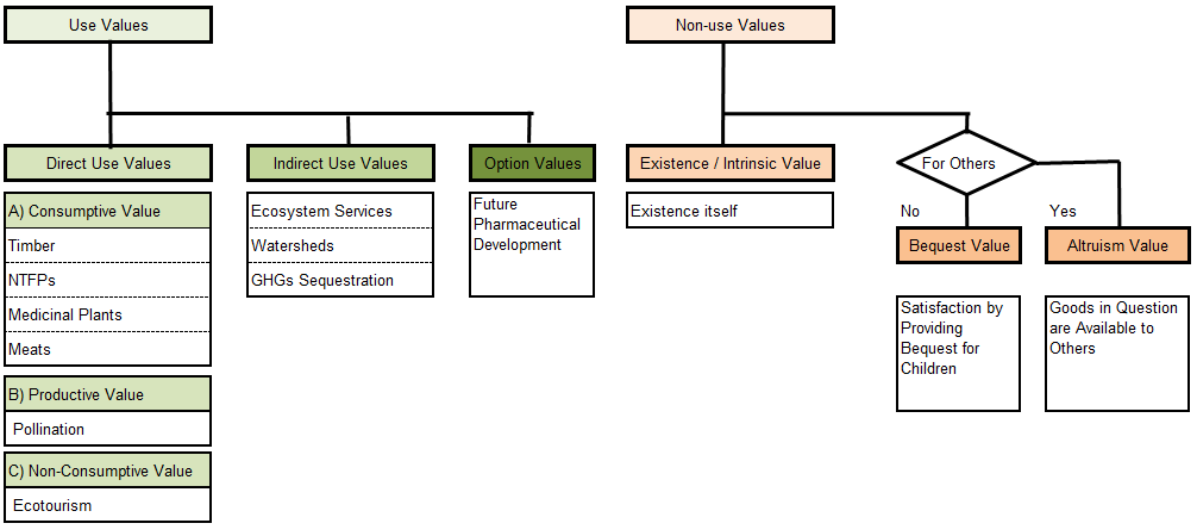
An attempt by Pearce *et al* for improvement is that bequest value is classified into two; bequest value (*i.e.* "for myself") and altruism value (*i.e.* "for others"), while previous classifications have only one value, say, bequest value. Besides this, all the classifications are the same as the previous ones; use values and non-use values; direct, productive and non-consumptive values; indirect values; option values (see below for details); and existence values.

3.1.2 Multiple Values Available for Other Environmental Issues and Beneficiaries

The second classification reflects characteristics of belongingness. Economic values do exist. However, the belongingness of each value differs. In other words, beneficiaries differ by each value respectively. (See Chart 3.1-C.)

[4] This section is from Sections 5.1, 5.2, 5.4 of Watanabe, Fujikawa, and Lu (2012) with modifications unless otherwise stated.

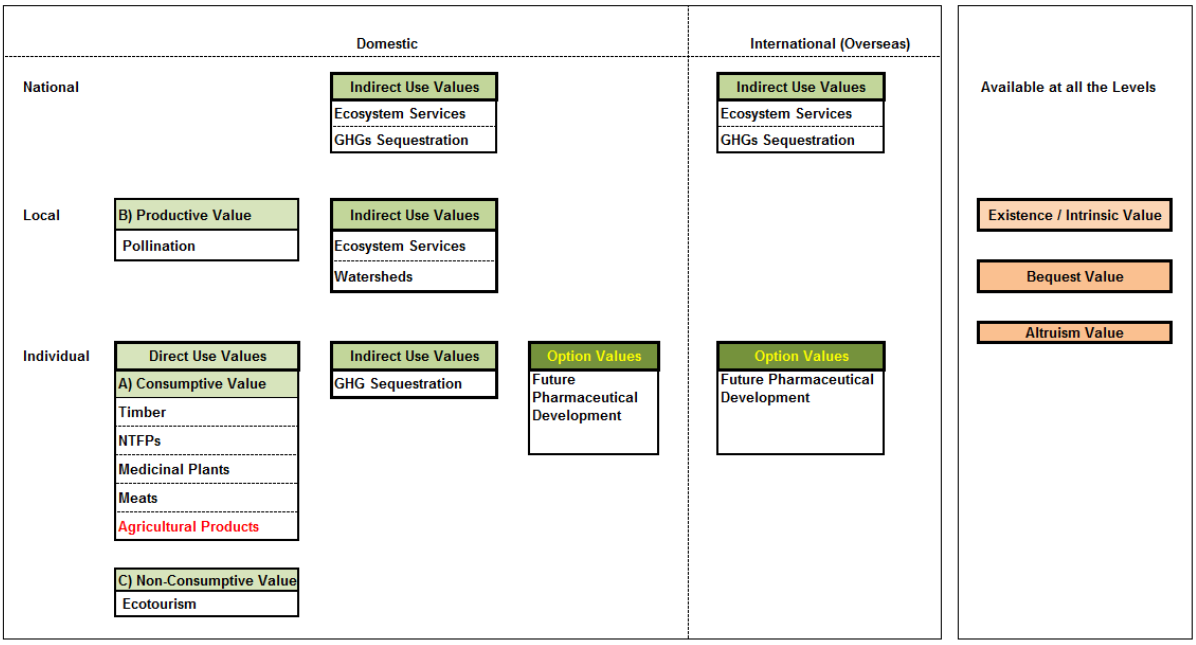
Chart 3.1-A Economic Values of the Environment (Example: Forest Biodiversity)



Source: Pearce, Atkinson, and Mourato (2006)

Chart 3.1-C Layers of Economic Values of the Environment (Example: Forest)

Classification of the Values by Beneficiaries



Source: Arranged by the author from Pearce, D., Atkinson, G., and Mourato, S. (2006).

For instance, suppose that some forest areas that are privately owned are conserved and that the conservation is for clean develop mechanism (CDM) under the Kyoto Mechanisms and resources can be extracted to the extent at which resources are renewable, typical economic values obtained are:

- Medicinal plants;
- Credits by CDM; and
- Watersheds protection.

Regarding belongingness (or beneficiaries), these three values have different beneficiaries. Medicinal plants basically belong to an owner, say, an individual. The owner can use it by him/herself or he/she can sell the plants in markets. In addition, unless the plants are merchandised, others cannot enjoy their benefits. With regard to CDM credits, it belongs to three categories. Firstly, an implementing agency – in this case, the land owner – can have benefits, receiving revenue from selling the credits. The value belongs to an individual and the beneficiary is the land owner. Secondly, CDM credits are regarded to be an achievement of greenhouse gas (GHG) reduction. The achievement belongs to the government as a party of UNFCCC. Hence, CDM credits value belongs to the nation. Beneficiaries exist at the national level. Thirdly, the rest of the world can benefit by CDM through reduction of GHG. Hence, benefits do exist at the international level.

This classification is important for this research because specifying beneficiaries is a crucial factor especially for cost-benefit analysis (CBA). CBA may consider benefits for individual, national, and international levels respectively [5] when beneficiaries are specified. In general, benefits of some project are estimated and benefits at the local level are considered as effects of the project. In this and the ABS context, an important thing is who beneficiaries should be, while the cost of establishing new laws/institutions is borne by the government and estimation of effects to the local level is reliable.

3.1.3. Clarifying the Option Values

There have been concepts of option value and quasi-option value in the context of values of the environment. They emerge especially when uncertainty and irreversibility on the environment exist. For instance, when there is an old growth forest in which useful genetic resources are expected to exist but the resources are unidentified yet and which the destruction process is irreversible, option value and quasi-option value emerge.

[5] It is logically correct but in many cases benefits are estimated in some limited areas technically.

Option value is conventionally defined as some values available when a decision is made to conserve some areas such as forests instead of "develop (*i.e.* being destroyed)". Quasi-option value is conventionally defined as some values available when the decision of "develop (*i.e.* being destroyed)" is postponed for a certain period.

Pearce *et al* (2006) pointed out confusion between the two values and clarified them into one value, a quasi-option value. Pearce *et al* has said that these two were the same eventually. Hence, this paper shall use the term, quasi-option value (QOV) from now on.

According to Pearce *et al* (2006), "Quasi-option value (QOV) refers to the value of information secured by delaying a decision where outcomes are uncertain, where one or more benefits (or costs) is uncertain, and where there is an opportunity to learn by delay (Pearce *et al*, 2006, p.147) (Underline by the authors) ". Key words are "uncertainty" and "irreversibility". In addition, a key concept is "the value of information".

It is widely known in the arena of biodiversity and CBD that information on genetic resources in habitats is uncertain unless some taxonomic research is carried out and that the loss of genetic resources is an irreversible process.

These facts reflect the situation of ABS very well into values. Postponing habitat destruction itself so that some research (*e.g.* taxonomic research or bio-prospecting) can be carried out as ABS can generate QOV, even if the research can eventually find biological and genetic resources with high market values. After the postponing of development, if there are no high value genetic resources, you may go ahead for development such as conversion of land for agriculture.

The point should be repeated:

1) When there are uncertainty and irreversibility, postponing "development" can always generate QOV;
2) This situation of postponing activities is very similar to postponing development for a certain period of time for research as ABS activities; and
3) Postponing habitat destruction can generate multiple values of biodiversity at least for some period.

If activities of ABS can always generate QOV, QOV can always increase the economic value of ABS, and QOV should be considered when the benefits of ABS are estimated.

QOV is strictly expressed as follows[6].

Three notions should be defined:

[6] Expressions on equations and variables in this section are cited from Pearce *et al* (2006) with modification by the authors unless otherwise stated.

1) Expected benefits from development (ED);
2) Expected benefits from preservation (EP), and;
3) Expected benefits from waiting (postponing) (EW). (Benefits may be called values but in this context, the term benefit is used.)

ED is obtained when the habitat is "developed" for agricultural land. EP is obtained when the habitat is conserved. EW is available when a decision is postponed and the habitat is preserved during the period of postponement, even if the habitat is developed after postponing. These benefits can be expressed by the equations below respectively.

$ED = D_0 + D_1$
$EP = V_o + pV_{1high} + (1-p)V_{1low}$
$EW = V_o + pV_{1high} + (1-p)\,D_1$

Where:
D_0 : Benefits from agriculture in time 0.
D_1 : Benefits from agriculture in time 1.
V_o : Benefits from preservation in time 0.
V_{high} : Benefits of some genetic resources found to be high after research.
V_{low} : Benefits of some genetic resources found to be low after research.
p : Possibility of finding high value genetic resources, $0<p<1$.

First of all, regarding D, if you decide to convert the habitat to agricultural production, agricultural development surely brings benefits in times 0 and 1 and the amounts are clear. In addition, if once the habitat is destroyed for land conversion for agriculture, the process is irreversible, and you can never have old growth forests with rich biodiversity again. Even if there is pressure on agricultural development in developing countries, the loss is crucial.

Secondly, if you decide to preserve the habitat, you can have V_o in time 0. You can have V_o that consists of multiple benefits but you cannot easily expect that V_o will exceed D_0 because D_0 is guaranteed and its values are high. If you do some research to exclude uncertainty or a lack of information on the resources, pV_{1high}, say high value from genetic resources at the possibility of p will be obtained. This may exceed D. In contrast, eventually you may not able to find resources with high value, say, just a low value resource. If so, the benefit will be $(1-p)V_{1low}$ at the possibility of (1-p).

ED and EP are expected benefits when you decide whether or not to develop now at time 0. In contrast, EW consists of benefits that can be obtained by postponing the decision during the period 0. The decision will be made at time 1. In other words, EW is some benefits that can be obtained if only you postpone the decision. During the postponement, the habitat is not destroyed and is preserved. EW has a positive value,

because in short, postponing the decision can leave preserved areas from which two options, say, development and preservation, are available again.

Postponing can always have V_o, because habitats are preserved during period 0. If resources are found to have high value at the possibility of p, this high value is thought to be obtained through postponing. On the contrary, even if high value resources are not found in the period 0, the land can be converted to agricultural land and you can have D_1 at the possibility of (1-p).

It should be repeated that postponing the decision - especially a decision for development -, can always generate benefits when uncertainty and irreversibility exist, because development can never leave an option of preservation while preservation always leave two options of development and preservation again.

Coming back to the terminology of "value", QOV can be expressed as:

QOV = EW – max(ED, EP)[7]

This equation expresses the strict meaning of QOV as the increase in expected value of benefits from waiting and says, "QOV is the difference between the expected value of waiting and whichever is the larger of ED and EP " (Pearce *et al*, 2006, p. 151).

3.2 Clarifying Costs and Benefits

In the descriptions above, the benefits are almost reflections of economic values and *vice versa*. Benefits are crucial factors in decision making and for ABS. In addition to benefits, costs should be considered. Costs and benefits should be simultaneously considered when decision making.

On the one hand, when some forest areas are developed, for instance, agriculture, the benefit is income from agricultural products with high certainty. This benefit falls within the category of monetary benefits and non-monetary benefits are not obtained in this case.

Regarding costs, the first cost is initial investment to start agriculture. If an implementer does not have land, the cost for land acquisition is needed. Even if he/she does acquire land, some costs are needed to cultivate the land. Equipment, inputs (*e.g.* fertilizer and so forth), and labour are needed for agricultural production. A large amount of transaction costs are not expected for agricultural development, unless there is conflict

[7] Max(ED, EP) implies that among ED and EP, the greater one is chosen and is calculated in the equation.

on the land. In addition to these costs, agricultural development has to bear opportunity costs of development. A typical opportunity cost is foregone benefits that may be obtained if the land was conserved such as future development of products derived from genetic resources. In addition, there always exist potential useful resources. Hence, QOV is opportunity cost as well when the availability of resources is uncertain.

On the other hand, some forest areas are conserved, especially for some ABS for a certain period of time. This situation assumes that forests are conserved before making a decision on whether they should be developed because there are uncertainties on available resources and some resources by ABS can exclude this uncertainty.

Benefits are, first of all, some multiple benefits of biodiversity available from conservation. Some fall within the category of monetary benefits and some in the category of non-monetary benefits. For instance, medicinal plants bear an economic value and are a monetary benefit. The economic value of watershed protection is a non-monetary benefit or a monetary benefit if it is evaluated and turns out to be a target of environmental tax. Furthermore, up-front payment for ABS is a monetary benefit while technology transfer is a non-monetary benefit.

Regarding costs, the first cost is initial investment to start some conservation activities and/or research for ABS. A special cost in this context would be certain costs to establish/revise some domestic laws/institutions to manage ABS in response to requirements of the Nagoya Protocol. Well-organised laws/institutions are expected to facilitate ABS, making the process clear and efficient. However, they cause initial costs. They may be considered an administrative cost in a broad sense. Costs for equipment, inputs, and labour are obviously necessary. Administrative cost is needed in order to regulate ABS so that appropriate benefits can be shared. A transaction cost is crucial to consider ABS. ABS negotiation needs more time and costs to reach an agreement in comparison to starting agricultural development. Hence, ABS has to bear more transaction costs. In addition, if this negotiation takes time even if some costs such as transportation costs are not needed, delaying benefits causes opportunity costs decreasing the value of benefits by increasing discounting more in the future. Conservation does have opportunity costs. Income from agricultural products is very high and conservation always has to bear the income as an opportunity cost. The last opportunity cost is very tricky. In many cases, in order to facilitate FDI, the government introduces an exemption. If the same case is adapted to ABS to facilitate access, the government's income from the tax will decrease. Exemption 'pays', because increases in access may result in increases from benefit-sharing. This increase may exceed a decrease in income from tax. However, until the government has a fruitful result, it has to bear a decrease in tax revenue.

3.3 Framework on Expected Benefits: Integration of Quasi-option Value (QOP), Costs, and Non-Monetary Benefits for Decision Making

Framework here tries to integrate all the benefits and costs pointed out above, including a new attempt on the estimation of non-monetary benefits. The framework is basically based on cost benefit analysis (CBA) and its modification, because this research assumes that decision makers involved in ABS are required to justify the introduction of new laws, institutions, regulations, and legislative, administrative or policy measures from the viewpoint of social benefit.

When CBA is considered, the framework focuses on *economic appraisal* as a decision criterion, while CBA has two criteria: *financial appraisal* and *economic appraisal*.

Framework by Conventional CBA

One ideal scenario could be this, when setting up a framework of CBA.

> In one developing country with rich biodiversity, one site with old growth forest is under discussion for whether the place is to be developed for agricultural production responding to the necessity of food production for the local community or preservation for CDM and watersheds acquisition. The development process is irreversible. Furthermore, there is uncertainty about genetic resources. Basic research on bio-prospecting under a scheme of ABS can reduce this uncertainty.

The conventional decision should be a dichotomy.

If the site is NOW decided to be developed FOREVER, ED will be obtained.
$ED = D_0 + D_1$

If the site is NOW decided to be preserved FOREVER, EP will be obtained.
$EP = V_o + pV_{1high} + (1-p)V_{1low}$

If the site is preserved for some period for research on bio-prospecting, EW will be obtained. In this case, a decision is NOT given NOW and the decision is pending during period 0.
$EW = V_o + pV_{1high} + (1-p)\, D_1$

Very rough criterion (see below for strict criterion) brings decisions. If ED > EP, the decision should be to develop the site. In contrast, obviously, if ED<EP, the decision should be to preserve the site.

A few important implications should be given here. Firstly, V very often possesses multiple – several – benefits when preserved. In this hypothetical and ideal scenario, V should possess: monetary benefits (economic value) of income from CDM credits and some possibility of revenue though bio-prospecting and non-monetary benefits of climate change mitigation, agricultural production by the preserved watersheds in some other areas, and technology transfer though bio-prospecting activities. Secondly, EW is always positive. Hence, waiting for results by bio-prospecting activities can always bring positive benefits/economic value.

For more strict criteria, equations should be rewritten including costs.

Development has to bear the condition below to be justified:
$ED - (CC + CO + CT) - OCD > 0.$
$= (D_0 + D_{1)}$
$- (CC_0 + CO_0 + CT_0 + CC_1 + CO_1)$
$- (OCD_0 + OCD_1)$

Preservation has to bear the condition below to be justified:
$EP - (CC + CO + CT) - OCP > 0.$
$= (V_o + pV_{1high} + (1-p)V_{1low})$
$- (CC_0 + CO_0 + CT_0 + CC_1 + CO_1)$
$- (OCP_0 + OCP_1)$

Where
Capital cost; CC
Operational; CO
Transaction; CT
Opportunity cost of development; OCD
Opportunity cost of preservation; OCP.

OCD and OCP are benefits by preservation and those of development respectively. When inequality is satisfied, development or preservation is acceptable.

Framework by Modification of CBA with Some Criterion of Strategy

EW and QOV have crucial roles when benefits and values are considered, especially when there are uncertainty and irreversibility on the genetic resources in the site. However, EW and/or QOV should not be included in CBA as long as they obey the conventional notion of CBA very strictly.

CBA is a tool by which a decision is made by information available NOW. This does not compare certain things that may be available in the future. If so, EW and QOV that

require some uncertain information in the future cannot be treated under CBA, even if EW always positive.

EW and QOV are very important in the context of ABS and the Nagoya Protocol. Simultaneously, the principle of CBA should not be violated. Hence, here, an extended CBA framework is to be introduced. The extended framework tries to include elements of strategy for the most appropriate decision. Two possible strategies are shown below.

Strategy 1 is to make a decision on development or preservation NOW.
Strategy 2 is to postpone the decision NOW and make a decision on development or preservation in period 1.

Expected criteria with benefits are:
Strategy 1:
ED = $D_0 + D_1$
or
EP = $V_o + pV_{1high} + (1\text{-}p)V_{1low}$.

Strategy 2:
EW = $V_o + pV_{1high} + (1\text{-}p)\, D_1$.

In the context of extended CBA with strategies, a crucial criterion should be:
Development now is justified when ED>EW. Postponing (waiting) is justified when ED<EW. You may consider a comparison between EP and EW but it is not necessary if you seek some periods and un-destructed habitats for research for ABS.

More strictly, inputting costs, criteria should be as follows.
ED with Costs : $(D_0 + D_{1)} – (CC_0 + CO_0 + CT_0 + CC_1 + CO_1) - (QOV)$
EW with Costs: $(V_o + pV_{1high} + (1\text{-}p)\, D_1) - (CC_0 + CO_0 + CA_0 + CT_0 + CC_1 + CO_1)$
Where: CA is administrative cost to establish new domestic laws and so forth for ABS.

Development (Strategy 1) is justified when (ED with costs) > (EW with costs). Postponing (waiting) (Strategy 2) is justified when (ED with costs) < (EW with costs).

Three factors should be emphasised in the context of ABS: Non-monetary benefits that are included in V_0; administrative cost (CA) to prepare domestic laws, institutions, regulations and the policy measures; and an existence of QOV.

Firstly, V_0 possesses non-monetary benefits of technology transfer about which quantitative estimations were previously unavailable. These benefits are unknown. However, previous research on FDI tells us that the influence on the domestic economy as a whole by FDI is often huge.

Secondly, CA should be carefully compared with benefits of facilitation of ABS by the protocol in this framework. Even if the Nagoya Protocol is meaningful, provider countries (or host countries) must bear an initial investment, say, a cost, CC, to set the policy measures.

Thirdly, QOV is always obtained unless, so to speak, development pressure with high expected benefit of D_0 (*i.e.* revenue from agricultural product) is certain. It means that waiting for development allowing some research on genetic resources is justified. During this period of time, QOV is generated and some information is obtained. An important thing is that the decision should be worth waiting for.

Before providing a proposed framework, one crucial element should be added. It is a parameter to adjust technological decay that increases the future value of preservation. Porter (1982) proposed a very suggestive parameter on a discount rate. When the destruction process is irreversible, a discount rate for benefits for preservation should be discounted, while the discount rate for development remains the same. It means that future benefits by preservation are expected to increase by the development of technology to find new genetic resources in preserved areas, while expected benefits for development should be discounted in a standard way. For instance, while benefits for development must bear a discount rate, *r*, benefits for preservation must bear the rate, *(r – a)*.

Wrapping up all the discussions above, the proposed tentative framework would be:

Strategy 1 ED with Costs

$$= \sum_{0}^{n}(D_t^{-rt}) - CT_o - \sum_{0}^{n}(\mathrm{CC}_t + \mathrm{CO}_t)^{-\mathrm{rt}}$$

Strategy 2 EW with Costs

$$= \mathrm{V_o} - (\mathrm{CA_0} + \mathrm{CT_0}) + \mathrm{p}\sum_{1}^{n} Vhigh_t^{-(r-\alpha)t} + (1\text{-p})\sum_{1}^{n} D_t^{-rt} - \sum_{1}^{n}(CC_t + CO_t)^{-rt}$$

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