ОПТИМИЗАЦИЯ МЕТОДА КОМПЕНСАЦИИ УЩЕРБА ОКРУЖАЮЩЕЙ СРЕДЕ ПРИ УСТАНОВЛЕННОМ ЗНАЧЕНИИ БИОТОПА ДЛЯ ЛАНДШАФТНЫХ ПРОЕКТОВ МОНГОЛИИ

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Аннотация

Под биотопом понимается среда обитания, отличающаяся от окружающей физической среды такими свойствами, как форма ландшафта, структура и совокупность живых организмов. Таким образом, биотоп имеет определенные размеры и однородные характеристики [1]. Цель данного исследования — оптимизация метода оценки и компенсации вреда окружающей среде для ландшафтных проектов в Монголии путем выявления его недостатков и внесения необходимых изменений с применением в качестве критерия метода оценки состояния биотопа, широко используемого и признанного эффективным в Германии (федеральная земля Гессен), Швеции, Намибии, Австралии и Чехии. Метод оценки состояния биотопа во многом сходен с большинством применяемых на практике методов оценки, например технологии быстрой оценки биоразнообразия. Быстрая оценка экологического состояния в сельской местности и ее «последователь» — оценка экологического состояния в сельской местности на основе участия представляют собой еще два примера методов из другой, однако не менее сложной сферы всесторонней оценки воздействия [2]. Данный метод в Монголии применяется начиная с 2010 г. Несмотря на то что он теоретически обоснован и детально разработан, на практике приходится иметь дело с очень сложным процессом, подверженным высокой степени субъективности, что приводит к разнице в показаниях. Данная разница зависит от того, кто производит расчеты, от используемых переменных параметра, допущений, принимаемых при отсутствии данных по причине их недоступности, и требующих много времени процедур оценки. Поскольку попытки создания полностью удовлетворяющего всем требованиям инновационного метода с высоким уровнем точности не увенчались успехом, представляется целесообразным пересмотреть и оптимизировать существующий метод, повысив его объективность и точность, что приведет к получению более единообразных и надежных результатов оценки. В Монголии использование надежного метода компенсации приведет к значительному повышению эффективности экономики природопользования при оценке ухудшения экологической ситуации и послужит ориентиром при расстановке приоритетов в защите окружающей среды. Компенсация ущерба окружающей среде станет важным вкладом Монголии в продвижение Конвенции о биологическом разнообразии и Национальной стратегии сохранения биоразнообразия 2016 г.

REDEVELOPMENT OF ENVIRONMENTAL COMPENSATION METHOD BASED ON ESTIMATED BIOTOPE VALUE FOR LANDSCAPE PROJECTS IN MONGOLIA

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Abstract

A «Biotope» is defined as a living place which can be distinguished from the physical environment around it by features like land shape, structure and even living communities within it, so it has a certain size and homogenous characteristic [1]. The objective of this study is to improve and amend the environmental damage and compensation assessment method for landscape projects in Mongolia by evaluating its shortfalls and necessary improvements using the biotope valuation method (BVM) as a benchmark, currently widely accepted and proven to be effective in Hessen, Germany, Sweden, Namibia, Australia and the Czech Republic. The biotope method has in common with most practically useful assessment methods, for example, the rapid biodiversity assessment approaches. Rapid rural appraisal (RRA), and its 'successor' PRA (participatory RA), are other examples of a similar kind, from a different but equally difficult area of comprehensive impact assessment work [2]. The current method in use by Mongolia, which was adopted in 2010, though well-grounded in theory and detailed, in practice, it involves a very detailed and complex process which has been proven to be vulnerable to a high degree of subjectivity and thus resulting in different assessment values depending on who is conducting the calculations, parameter variables being used, any assumptions made in the absence of data that is not always available, and the time consuming procedures the assessment. Since it proved difficult to create a fully satisfying and innovative method with noticeably improved levels of accuracy, it was deemed more suitable to redevelop and amend the current method to lower complexity and subjectivity levels to improve its objectiveness and accuracy, which will result in more uniform and reliable assessment results. A well-developed compensation method in Mongolia could mean a notable improvement in local capacity for environmental economics in the valuation of environmental degradation and a new point of reference for environmental priority setting. Compensation of damages to the environment will be an important contribution of Mongolia toward the aims of the Convention of Biological Diversity (CBD) and the National Biodiversity Action Plan approved in 2016.

Introduction

In 2012, Mongolia made successful efforts to further develop the environmental law sector and improve legal implementation procedures with the introduction and implementation of a new environmental law package. The practical use of the current environmental damage estimation method is restricted by its many variables, unreliable constants in the formula defined by possibly inaccurate and inconclusive studies, a complex process and a lack of supporting database. Being highly subjective, due to the data requirements and complexity, the estimates are unreliable and lack consistency each time the assessment is repeated by someone else. Moreover, the method that further converts the estimated numbers into monetary value is also time consuming and prone to errors due to the overcomplicated process.

In addition, due to a shortage of laboratory capacity and trained professionals, retrieved samples of soil, water and air are not sufficiently and competently analyzed, resulting in unreliable laboratory findings, which further confuse

the stakeholders on necessary further action. When the findings cannot be relied upon, it is often that a court decision is put on hold, and no further action is taken. The environmental damage that should be in the process of restoration is then left as it is. In the last 10 years, there were thousands of cases registered of violations regarding environmental restoration but only a few of these went to court. Of these cases that went to court, none resulted in environmental restoration or compensation¹.

Measurements performed by people on resources in accordance with these methods is not used very frequently in practice. Some of the proposed monetary evaluation criteria, such as the contingent valuation method and the travel cost method, can be extremely subjective and may lead to unreliable results. Moreover, the common feature of all these methods is that they are not well suited to measure non-use values such as those of biodiversity. Because of these difficulties, resource equivalency methods based on biotope were developed in the 1990s.

¹ Official letter from Police Administration agency, 2017.

An international study of similar estimation and compensation methods was run for benchmarking purposes. In the European Union, the Environmental Liability Directive (ELD) provides the main framework of remediating and preventing environmental damage, which is also the minimum requirement for a liability regime. The ELD imposes both strict- or fault- based liability for damage to the species and habitats covered by the EU Wild Birds and Habitats Directives, for contamination of land, and for damage to waters covered by the Water Framework Directive. This directive encourages the development of financial security instruments and markets and asks mining operators to use financial guarantees to cover responsibilities. Within the directive, there are requirements to inventory abandoned and closed waste facilities that have serious negative environmental impacts. In particular, Germany's regulations² and rules that followed the Nature Conservation Act, as agreed in 1976, were the focus of this study because it is transparent, easy to understand and has been well implemented in the Hessian state for the last few decades. In Germany, the most environmentally harmful activities are considered to be mining exploration, construction and infrastructure project³. The method determines the environmental impacts and degradation through a biotope system. This biotope system aims to determine environmental impacts by setting ecological values on each component of the environment. In addition, ecological value is estimated by whether and to what extent the component is considered to be beneficial and necessary for the environment as well as how vital it is considered to the natural ecosystem or offsetting activities.

All biotopes are ranked by 8 ecological characteristics that are aggregated into a resulting number of scores. In the case of Mongolia, the biotope valuation method (BVM) can be used after the differences in habitat and values are taken into account. The main variables that should be modified are landscape capacity to be restored, the carrying capacity of resources, whether or not the landscape is under redevelopment, environmental assessment of soil, fauna and flora, possibility of reutilization of the landscape in post-reclamation and the abundance and diversity of the landscape.

The monetary value of a biotope reflects the average restoration cost over the years necessary for restoration and maintenance. The monetary value of a point in the Czech Republic is 0.49 cents, while in the Hessian state of Germa-

ny, it is 0.35 cents. These values are derived from a set of representative restoration projects over the years, as the average national value necessary to improve one value-point of the biotope by 1 full score⁴. Using this methodology, every ecosystem was separated into 1–11 categories and given a total of 3–63 bio-credits in Germany.

Biodiversity is assigned to one of three levels: low (1–13 points), moderate (14–17 points) and high (18–21 points). 'Low' corresponds to general biotope, 'moderate' corresponds to rare biotope, and 'high' corresponds to critical biotope as defined in the Biotope Method, Vattenfall 2005⁵.

Materials and Methods

Objectives to achieve were divided into 1) develop framework to estimate the cost of environmental damage to surface mining sites and 2) comparison of methodologies at one project site. Two different kinds of estimates were provided to reflect the uncertainty of the results. Damage costs are presented in the following values (in local currencies, Tugrik) and using Germany's biotope valuation method (BVM) the calculated cost estimation of damage needs to be converted using comparison factors of Mongolian and Germany's gross domestic product (hereafter GDP) values. Expressing costs as a share of GDP provides a sense of magnitude, and will allow for cross-country comparison.

The usage of Mongolia's existing compensation method. As part of the study to determine and to calculate the environmental impact and required compensation, mining site «A», located in Khan Uul District of Ulaanbaatar, was used. The ecological and environmental impacts that may occur to the environment inclusive of natural resources, water, soil, flora, fauna, forest, animal and their habitat due to exploitation activities of mineral resources are listed below using the current estimation method.

1. The environmental impact due to mining activities of sand quarrying of this site (in territory of Khan Uul district) since their licensing in 2000, has been estimated at 24 hectares of damaged land. The location of the licensed mining site, as defined by «Resolution No. 5/39» approved on 16th July 2010 by the Citizen's Representative

⁴ Richtlinien zur Bemessung der Abgabe bei Eingriffen in Natur und Landschaft. URL: <http://www.worldcat.org/title/richtlinien-zur-bemessung-der-abgaben-bei-eingriffen-in-natur-und-landschaft/oclc/75296172> ; Valuing Ecosystem Functions and Services in the Czech Republic. 2011. URL: https://www.researchgate.net/publication/272169246_Valuing_Ecosystem_Functions_and_Services_in_the_Czech_Republic.

⁵ The Biotope Method. A method for calculating the impact of land use and water use. URL: https://corporate.vattenfall.com/globalassets/corporate/sustainability/reports/vatt_3238_broschyr_biotopmetoden_eng_h.pdf.

² Verordnung über die Umweltverträglichkeitsprüfung bergbaulicher Vorhaben (UVP-V Bergbau), 1990.

³ Ibid.

Khurals of Ulaanbaatar city, land usage fees for 1 m² of land for business purposes, was set at 440,000 Tugrik per year⁶.

2. While calculating the damage to earth bowels, it is important to estimate and take into account the volume of 1 m³ mining soil bowl works expected to be executed for the purpose of extracting mineral resources.

3. The topmost layer of soil is damaged due to frequent and heavy truck movement in licensed mining areas and their surroundings. This type of soil damage/soil chemical and mechanical properties, humus stratum's compost and soil quality and geographical parameters considered/are calculated only to the sand pit area. The total area damaged was estimated at 3.8 hectares.

4. Transportation to and from the sand quarrying site was restricted in the north-south directions but extended widely enough in west and east. This area was used as pasture land by herders and farmers. The mountain peak on the flat arid plain — was covered with true grass-caragana-composition. In total, 41 genus were identified. Damage to the native plants and herbs caused by sand and gravel mining has been estimated in accordance with Method of Ecological and Economic Value of Plant's Cover approved in Decree No. 157 by the Minister for Environment and Tourism of Mongolia, dated May 17, 2010⁷.

5. In order to identify the rate of air pollution, it is important to determine maximal contents of poisonous substances permissible for different environments. The criteria for assessing the extent of environmental pollution was expressed by the ratio of the content of poisonous substances in a relevant environment to the maximal permissible level or content (or precaution value) of those substances. The maximal permissible content of different substances was fixed as shown in Table 1. Cost estimation within the current existing method at surface mining site «A».

The most common air pollutants such as ash, non-organic dust and persistent organic pollutant such as benzapirene [3] were all added into the equation by calculating their respective impacts on air pollution.

6. The valuation of environmental restoration costs was made in accordance with Decree No. A-138 by Minister for Environment and Tourism dated March 30, 2015⁸.

⁶ Resolution No. 5/39 approved on 16th July 2010 by the Citizen's Representative Khurals of Ulaanbaatar city.

⁷ Method of Ecological and Economic Value of Plant's Cover approved in Decree No. 157 by the Minister for Environment and Tourism of Mongolia.

⁸ Decree No. A-138 by Minister for Environment and Tourism dated March 30, 2015.

Table 1
Cost estimation within the current existing method at surface mining site «A»

Nr.	Environmental components	Cost estimation In Mio Tugrik
1	Land	95.0
2	Subsoil	87.4
3	Soil	53.7
4	Plant cover	21.5
5	Air	0.6
Subtotal		258.2
1	Amount of technical restoration expenses	74.1
2	Re-covering costs of topsoil	6.16
3	Amount of biological restoration expenses	5.44
4	Monitoring expenses	10.1
Subtotal	Restoration expenses	95.8
Total		354.0

The usage of Germany's biotope valuation method (BVM). BVM is used for assessment and calculation of environmental impacts before a project starts in Germany and Czech Republic and also it is equivalent for habitat equivalency assessment in the USA⁹. The Resource Equivalency Methods for Assessing Environmental Damage in the EU (REMEDE) toolkit and a coal mine in the Czech Republic were used as examples to describe how the REMEDE toolkit can be utilized to calculate environmental liabilities. In this case study, environmental damage is incurred on 10 hectares of land in a terrestrial oak forest and 10 hectares of wetland. Damage to resources, habitats and environmental services were described using the following metrics: vegetative cover, biodiversity and temperature amplitude. The average cost of the biodiversity metrics, remediation costs were estimated at approximately 1.1 million Euro for forest remediation, and 103,000 Euro for wetland habitat remediation in this Czech coal mining case study¹⁰.

BVM was originally developed in the Hessian state of Germany, which has implemented it in 1992 — so for the last 26 years already. The method is based on the total point value of specific biotope, derived from the valuation of eight

⁹ Habitat Equivalency Analysis: Damage Assessment and Restoration Program National Oceanic and Atmospheric Administration Department of Commerce, 2000. URL: <https://casedocuments.darrp.noaa.gov/northwest/cbay/pdf/cbhy-a.pdf>.

¹⁰ Valuing Ecosystem Functions and Services in the Czech Republic. 2011. URL: https://www.researchgate.net/publication/272169246_Valuing_Ecosystem_Functions_and_Services_in_the_Czech_Republic.

different ecological and economic characteristics (each in relation to the Hessian method).

Point value (PV) equation = $[(M + N + DL + DS) (RB + RS + SB + TB)] \cdot 100 / 576$. (1)

These are biotope matureness (*M*), naturalness (*N*), diversity of biotope structures (*DL*), diversity of biotope species (*DS*), rareness of biotope (*RB*), rareness of species of biotope (*RS*), sensitivity (vulnerability) of biotope (*SB*) and threat to number and quality of biotope (*TB*)¹¹.

The sum of points achieved in the first four characteristics was multiplied by the sum of points achieved in the four remaining characteristics. The figure obtained was divided by the maximum of weighted values (576) and multiplied by 100. The point value of respective biotope type shows its relative ecological significance compared to other biotopes. Based on eight of the above mentioned ecological characteristics, a complete list of biotope types for the territory of the Czech Republic was created (currently including NATURA 2 000 biotopes, extended by underground water biotopes) with their respective point values, showing the ranking of biotopes according to their ecological quality (biotope's life-supporting potential). The list of biotope types is enclosed (point values are related to 1 m² of respective biotope)¹².

Point values were transferred into monetary terms by the average national restoration costs necessary per one point increase. Around 140 restoration projects have been analyzed that had already been implemented over the last five years in different parts of the Czech Republic. The financial value of one point was counted for one revitalization project as a sum of its costs divided by a sum of the point increase expected in the long-term future (future values were discounted by 0 discount rate) and finally national average costs per one point increase were calculated by weighted arithmetic average¹³.

¹¹ Method of monetary valuation of territorial ecological function. URL: <http://fzp.ujep.cz/Projekty/BVM/BVM.pdf>.

¹² Valuing Ecosystem Functions and Services in the Czech Republic. 2011.

¹³ Ibid.

Table 2
Cost estimation for BVM at surface mining site «A»

Nr.	Before mining biotope	ha	value	Sum of biotope values
1	Dirt road	1.0	21	210 000
2	Pasture land	21.5	25	5 375 000
3	Temporary creek	1.5	29	435 000

End of the table 2

Nr.	Before mining biotope	ha	value	Sum of biotope values
	Before mining (total)	24.0	75	6 020 000
	During mining			
1	Dirt road	1.5	21	315 000
2	Pasture land	17.02	25	4 255 500
3	Temporary creek	2.1	23	483 000
4	Sandpit	2.7	16	433 000
5	Topsoil sandy dump	0.6	16	96 000
6	Parking area	0.08	3	2 400
	During mining (total)	24.0	104	5 583 400
	After mining			
1	Dirt road	1.0	21	210 000
2	Temporary creek	1.5	29	435 000
3	New pasture	4.5	16	720 000
4	Old pasture	17.0	25	4 250 000
	After mining (total)	24.0	91	5 615 000

From Table 2:

– difference = before mining value – [during mining value · 0.1 + after mining value · 0.9] = 408 160 biotope values;

– transferring into monetary value = 408 160 biotope value · 0.32 cents = 130, 611 Euros = 384 Million Tugrik.

By comparing the results from the current method and BVM, differences and inconsistencies can be seen. By using the current method, the environmental damage at this site is 354 Million tugrik and using Germany's BVM, we have an estimated cost of 421 Million tugrik. The necessity to fix this difference in results by amending and improving on the current method can be seen from this.

First and foremost, an equalizing factor is needed between the two methods to determine the monetary values to be used in Mongolia's case with BVM.

By dividing the monetary value of 1 point value of Germany being 0.32 Euro/PV by the above calculated average value, one point value of Mongolia can be calculated as follows:

– 1 Point Value of habitat valuation in Germany = € 0.32.

The average ratio is 11.25, calculated using the exchange rate at the Mongolian state bank 2945 tugrik for 1 Euro.

– Exchange rate between Euro and Tugrik: 2,945 × € 0.32 = 942 Tugrik.

– Conversion using GDP ratio: $942 / 11.25 = 83.8$ Tugrug.

– Valuation of 1 Point Value of biotope in Mongolia = 83.8 Tugrug / PV.

Table 3

	GDP ratio			
	World bank	International Monetary fund	CIA	UN
Germany's GDP	45,085	44,999	44,300	41,376
Mongolia's GDP	4,056	3,971	3,900	3,673
Ratio	11.1	11.3	11.3	11.3

Note. R = Germany's GDP per capita / Mongolia's GDP per capita, average Ratio is 11.25.

Additionally, in case of Mongolia, there is data limitation on the country's ecological baseline studies for BVM, since the biotope types and their classifications were never determined in the past. Therefore, it is not possible to create a map using all 8 characteristics of the Hessian method. 576 is the maximum of weighted values for 8 characteristics. However, it is considered, that the valuation of habitats could be possible based on available data and information, using the 6 characteristics of: productivity, naturalness, diversity of biotope species, rareness of biotope, sensitivity/vulnerability of biotope and threat to number and quality of biotope. Instead of 576, we would have the maximum of weighted values of 225 in Mongolia.

$$PV = [(P + N + DS) (RB + SB + TB)] \times 100 / 225. \quad (2)$$

After the reformulation of the environmental damage method, the final statement of cost estimation of environmental damage consists of a sum of cost of preparation activities like data collection, reclamation, biotope point valuation and cost of monitoring and sampling works in the planned time:

$$C = C_p + C_r + C_h + C_m, \quad (3)$$

C — Total amount of cost estimation of environmental damage; C_p — Cost of preparatory activities; C_r — Cost of obtained reclamation and restoration activities; C_h — Cost of biotope valuation; C_m — Expenses related to monitoring and sampling activities.

Additionally:

$$C_p = (C_r + C_h) 0.05 \%. \quad (4)$$

$$C_m = (C_r + C_h) 0.05 \%. \quad (5)$$

Therefore the cost of reclamation and restoration (C_r) and cost of biotope valuation (C_h)

need to be calculated separately. The determination of 1 m² biotope value is as follows:

$$C_h = PV \cdot AV. \quad (6)$$

This is as follows: AV = biotope value 83.8 tug/m²; PV = biotope point value.

From this, to estimate the cost of environmental damage within 1 hectare of area:

$$C_{ha} = C_p + C_r + C_h + C_m. \quad (7)$$

These are: C_{ha} — Total cost estimation of environmental damage; C_p — $(C_r + C_h) 0.05 \%$; C_r — Cost of restoration /each ecoregion is differently defined; C_h — $PV \cdot 83.8 \cdot 10\,000$; C_m — $(C_r + C_h) 0.05 \%$; $D = 1 / (1 + r)^T$, r — Inflation rate, T — Time (year).

Finally, the total cost estimation of environmental damage per 1 ha area is as follows:

$$C_{ha} = [(C_r + (PV \cdot 838\,000)) + (C_r + (PV \times 838\,000)) 0.10] \cdot D. \quad (8)$$

Using the restructured method in Mongolia

We have a formula which states that the total estimated cost of environmental damage is equal to $C = C_p + C_r + C_h + C_m$.

That means: C = 118 Million Tugrik according to the newly restructured method. The abandoned sand pit site has an environmental value of 118 Million tugrik.

Conclusion

This paper is a contribution in the process towards the use of environmental damage cost assessments for priority setting and as an instrument for integrating environmental consideration into economic and social development plans since Mongolia is currently adopting a green development strategy. This approach is necessary to avoid social costs to the economy of Mongolia, resulting from damages left behind by individual enterprises.

By combining biotope values with 6 characteristics, the development of total national value of biotopes as the monetary value of national natural capital was quantified.

This method is applicable in the evaluation of ecological damages caused by both development projects and/or illegal activities. The biotope method was approved by Minister's Order A-14 in 2016¹⁴.

Using the current method instead of BVM, ecological components such as air, soil, water, plants and animals were considered separately

¹⁴ Biotope Method, Minister of Environment and Tourism of Mongolia, A-14/2016.

Biotope scores of Mining site using a bio landscape map from WWF [4]

and due to very common and small mechanical mistakes, the results mostly succeeded in only confusing the stakeholders. The environment — and the state — were left as victims. In contrast to this, BVM is broadly used and accepted in some European countries; it is transparent, simple and clear. It treats the problem as a part of the bigger picture, as an interaction of all living components between biotopes. The unique variables in Mongolia's BVM equation should consider a lower GDP in order to make compensation amounts feasible, a different system of land ownership, an ecological system identified as the steppe, migrating wild animals, water scarcity and the uneven distribution of the population. A biotope value map needs to be developed according to Mongolia's characteristics to support this new approach.

Research limitations/implications

Owing to data constraints, no cost estimates are provided for some impacts such as: degradation associated with industrial, hazardous and hospital waste, biodiversity loss, and impact of inadequately treated wastewater. These calculations often represent lower bound estimates. In this regard, rapid bio assessment programs have been quickly accepted and now cover most of the United States (US) and equivalent programs cover all of the United Kingdom (UK). Rapid bio assessment programs are designed to screen large regions, pinpointing trouble spots worthy of more detailed information such as whether poor water quality or de-

graded habitats are stressing the invertebrate communities [5].

In the case of Mongolia, modified indicators need to be developed by taking into account the diversity of landscapes, the average cost estimation for restoration and rehabilitation activities in different natural zones and climate change issues. Since the major and the most harmful sector to the environment of the country is mining, it is important to take into account following indicators such as surface depth of mining activities, impact on migratory species, and the geographic and climate impacts. Finally, it is needed to determine the harmonization of total cost estimated by this method, actual reclamation and monitoring cost and the need of further improvement and amendments in the current legislation.

Future needs include: the development of procedures that can be applied to large rivers and lakes; further refinement of ecological principles underlying metric choice; the inclusion of chemical criteria and toxicity tests to establish thresholds that indicate impairment; and the development of criteria indicating the necessity for implementation of quantitative assessment studies [3].

Research results can be used in microeconomics to construct economic instruments for protection of nature and landscapes in Mongolia. Such new economic instruments can partly change economic agents' behavior toward sustainable development.

For global sustainable development, it would also be beneficial to disseminate and ap-

ply this methodology of biotope monetary valuations to other countries in Asia. But the study had to cope with country specific differences in terms of data availability, valuation methods, landscape peculiarities and relations between supply and demand aspects [6].

Finally, it must be stressed, that a close interconnection with development design and planning is a precondition for successful implementation of any of these models, especially within the more intensively used landscape projects [7].

By using of comprehensive and selective biotope method are jointly used in research, but in terms of accuracy of biotope classification and comprehensive degrees, there still exists a certain gap among the newly adopted and experienced countries [8].

For examples: further opportunities for improvement exist in terms of dealing with secondary impacts, as well as the possibility of using other types of indicators for biodiversity such as different groups of taxa [9].

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